Practical Navigation:

OR,

An Introduction to that whole Art.

CONTAINING

1. Several Definitions in Geometry, Astronomy, Geography, and Navigation.
2. A new and exact Kalender, shewing the Suns Declination and true place, for 60 years.
3. And an Almanack of the Moon for eight Years.
4. The Calculation of Triangles, both plain and Spherical, and their Application in Navigation.
5. The form of keeping a Journal, or Sea reckoning.
6. Several useful Tables, as Tables of Meridional parts; Latitudes and Longitudes of Places, &c.
7. The Original Invention of the Mariners Compass.
8. A Discourse of the Variation, and the Natural Causes thereof.
9. The Description and Use of the most necessary Instruments in Navigation, as the Cross-Staff, Quadrant, Azimuth Compass, &c. the Inclinatory Needle, to find the Latitude of a place without Observation of Sun or Stars.
10. With an Appendix, shewing the secret Virtues of the LOAD-STONE.

By JOHN SELLER, Compass-maker.

LONDON,
Printed by *J. Darby*, and are to be sold by the Author, at his Shop, at the Sign of the *Mariners Compass*, at the *Hermitage* in *Wapping*; and by *John Wingfield*, at his Shop, right against St. *Olaves* Church in *Crutched Friers*, 1669.

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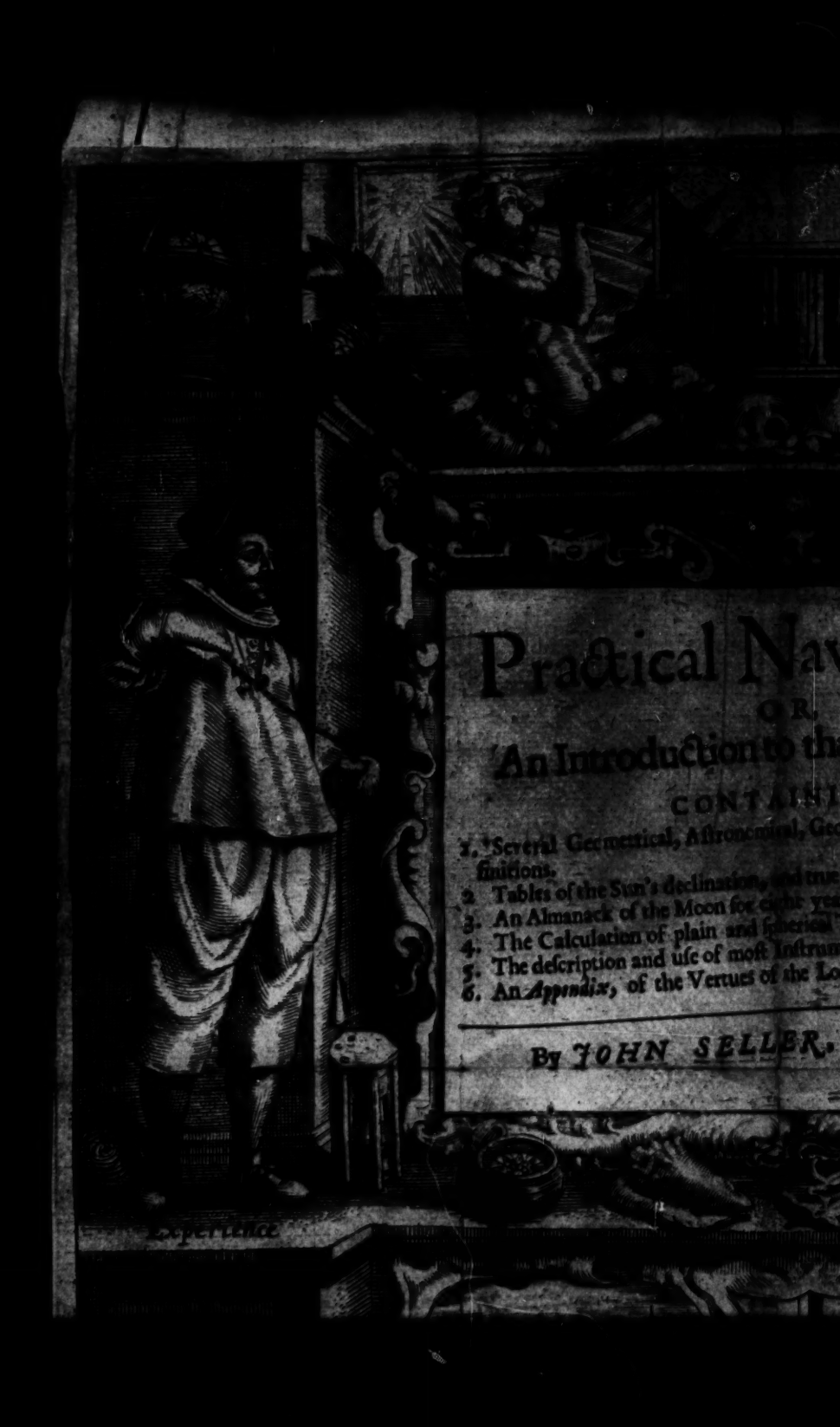
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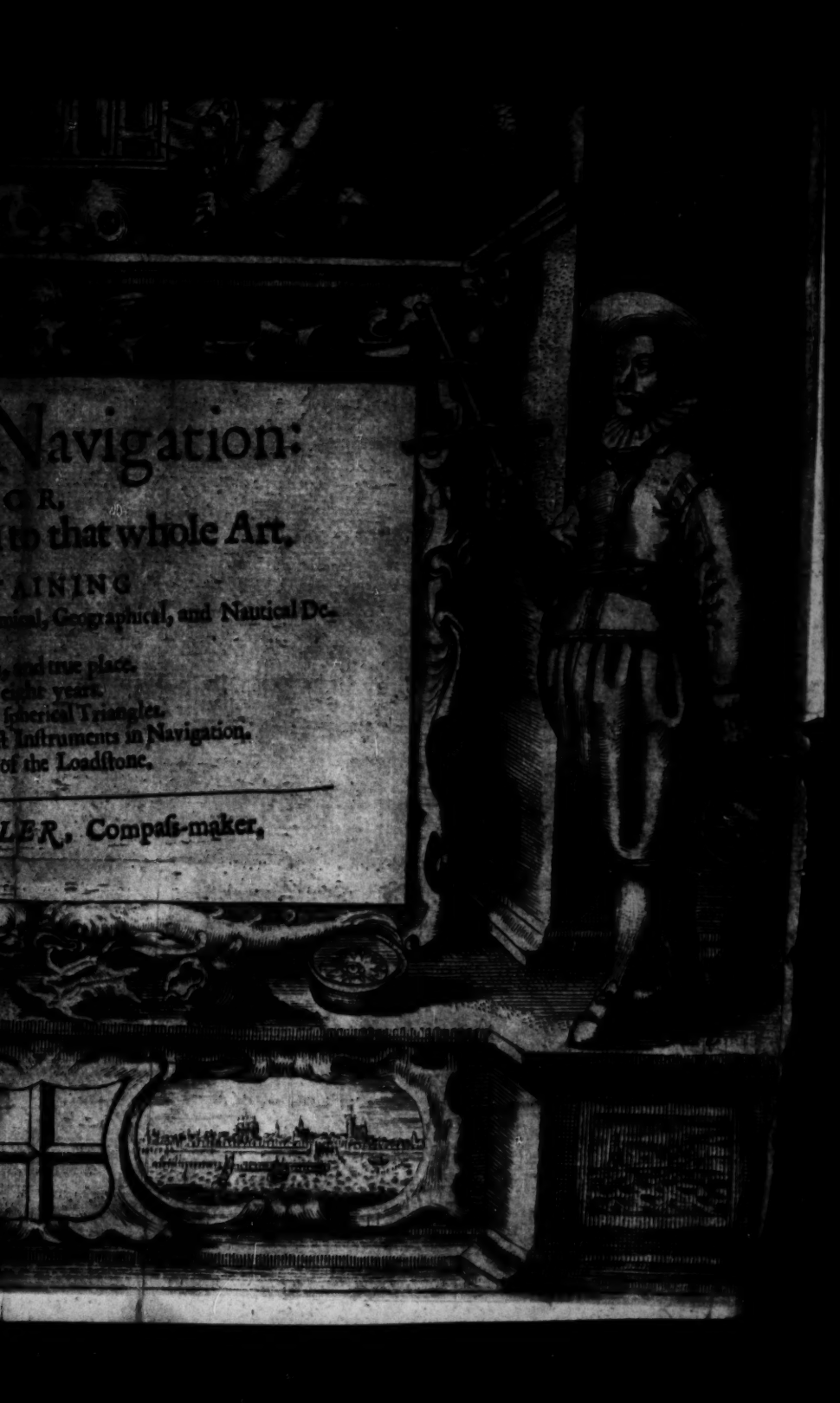
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PATENT OFFICE LIBRARY

To the Worshipful

Sir Nicholas Millet, Kt.

JOHN SELLER,

IN

Acknowledgment of many Favours received from Your VVORSHIP,

Presents this small TREATISE

OF

Navigation.

The Preface.

To all those Worthy Persons, the Captains and Commanders of Ships; and to all other Officers and Mariners whatsoever of our English NATION.

Worthy Gentlemen,

IT is not unknown unto most of you, what great improvement, and to what perfection the noble Art of Navigation hath arrived to in this last Age of the World, the principal part thereof may justly be attributed to the industry of our Countreymen, who are not inferior to any other Nation whatsoever; but their improvements therein have been more then any of them, as testifies a late famous Professor, * and great Mathematician, *Hoc certum est omnibus hodie Gentibus Navigandi Industriâ & peritia superiores esse Anglos*, That is, This is certain, that the English excel at this day all Nations, in their industry and skill of Navigation, and there are many excellent Treatises of that nature extant, that are scarce paralel'd in any other Nation: And it might be thought altogether needless for such a Messellaneous Tractate as this is to come forth to the World; but the reason of my writing hereof, was occa-

* *Keckerman.*

occaſioned by my Profeſſion, in making and ſelling ſeveral Inſtruments of Navigation, the Buyers many times deſiring to be informed in the Practical uſe of them, which cauſed me much loſs of time to inſtruct them therein by word or writing; and many times they were diſappointed of their expectations, my other Affairs occurring, which moved me to write ſomething concerning the moſt uſeful Inſtruments in Navigation; and in the doing of that, other Contingent Matter came into mind, which I judged neceſſary, by way of Introduction, ſomewhat relating to that Subject, which cauſed this Book to ſwell into a greater Volumn then was intended: And herein perhaps I may be expoſed to the cenſure of ſome, but I hope to receive a more favourable conſtruction from the judicious and induſtrious Mariner, for whoſe uſe I write this enſuing Diſcourſe, whoſe pardon I crave for any unskilfulneſs therein manifeſted. And by the reaſon of the little time I could ſpare from my other buſineſs, ſeveral diſorders and faults are committed, which I deſire the ingenious Reader to over-look and paſs by, upon the account of humane frailty; which ſhall oblige me to be further ſerviceable, according to the extent of my abilities. *Vale.*

John Seller.

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The

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The way of obſerving by the Croſſiers.

The Deſcription and Uſe of the Nocturnal, and of the Moon-Dial.

The Uſe of the Plain Scale in Plain, and Mercators *Sailing.*

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With an Appendix of the ſecret Properties of the Load-ſtone, and ſome Magnetical Concluſions performed thereby.

Practical Navigation;

OR

An Introduction to that whole Art, &c.

CHAP. I.

Containing certain Diffinitions and Expoſitions of ſeveral terms of Art, uſed in Geometry, Trigonometry, Aſtronomy, Navigation, and Geography, &c.

Geometrical Diffinitions.

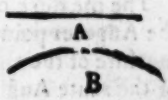
Diff. 1.

A Point or prick is the leaſt of all Materials, having neither Part nor Quantity, and therefore void of Length, Breadth and Depth; repreſented in the Margine by the Letter A.

A.

Diff. 2.

A Line is a ſuppoſed Length extending it ſelf without Breadth or Thickneſs, whether it be ſtrait or circuler, as may appear by the ſtrait Line A, and the crooked line B, in the Margine.



Diff. 3.

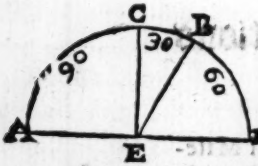
An Angle is the meeting of two Lines in such sort as they do not make one Line, as is expressed in the Margine; and of them there are three sorts, *viz. Equilateral, Iscoscles*, and *Scalenum*.

An *Equilateral* Triangle hath three equal Sides, and three equal Angles, as the Figure A in the Margine.

An *Iscoscles* Triangle hath two equal Sides and two equal Angles, as the Figure B in the Margine.

A *Scalenum* Triangle hath the three Sides and Angles all unequal, as may appear by the Figure C.

Diff. 4.



All Angles are either Right, Acute, or Obtuse.

A right Angle is that which containeth 90 Degrees; as the Angle C. E. A. in the annexed Figure.

An accute Angle is that which is less than 90 Degrees, as the Angle C. E. B. containing 30 Degrees, and the Angle B. E. D. containing 60 Degrees in the annexed Figure.

An Obtuse Angle is that which is more then 90 Degrees, as the Angle B. E. A.

The measure of every Angle is the Arch of a Circle, described on the Anguler point; as in the foregoing Figure the Arch A. C. is the measure of the right Angle C. E. A. The Arch C. B. is the measure of the acute Angle C. E. B. and the Arch B. C. A. is the measure of the obtuse Angle A. E. B.

Diff.

Diff. 6.

Every Circle therefore is ſuppoſed to contain 360 Degrees, every Degree 60 minutes, and every minute 60 ſeconds, *&c.*

Diff. 7.

A Semicircle is the half of a whole Circle, containing 180 Degrees, as in the precedent Figure, the Arch A. C. D. containeth 180 Degrees.

Diff. 8.

A Quadrant is the fourth part of a Circle, containing 90 Degrees as is expreſt in the Arch B. C. D.

Diff. 9.

The Complement of an Angle to a Quadrant is as much as that Angle wanteth of 90 Degrees; as the Complement of the Angle C. E. B. which is 30 Degrees (in the foregoing Figure) is the Angle B. E. D. which is 60 Degrees, for 30 and 60 make 90.

Diff. 10.

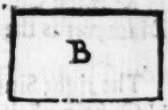
The Complement of an Angle to a Semicircle is ſo much as the ſaid Angle wanteth of 180 Degrees, as the Complement of the Angle B. E. A. 120 Degrees is the Angle B. E. D. 60 Degrees; for 60 and 120 doth make 180.

Diff. 11.

Four ſided Figures are ſuch as are contained under four lines or terms and are of divers ſorts.

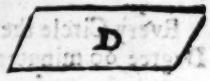
1. There is a Quadrant or Square, whoſe Sides are equal, and Angles are right, as the Figure A.

2. The Oblong, or long Square, whoſe Angles are right, but the Sides unequal, as the Letter B.



3. The Rhombus or Diamond-like-Figure having neither equal Sides nor equal Angles, as the Figure C.

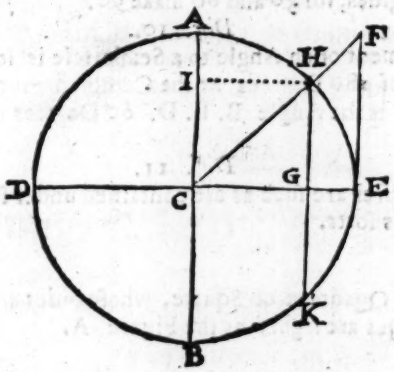
4. The Rhomboides is a Figure having neither equal Sides nor equal Angles, and yet the oppoſite Sides and Angles are equal, as the Figure D.



5. All other Figures of four ſides are called *Trapezia*, as the Figure E.

Diff. 12.

Right Lines applied to a Circle, are Chords, Sines, Tangents or Secants. A Chord is a Right Line drawn in a Circle from one part of the Circumference to another, as in the annexed Figure.



H K is the Chord of the Arches, H E K and H D K, alſo D E the Diameter is the Chord of the Semicircles D A E and D B E.

Diff. 13.

The right Sine of an Arch is half the Chord of twice that Arch, as H G being half the Chord H K is the right Sine of the Arch H E, alſo of the Arch H D K, the Arch H E being the half of H E K and the Sine Complement of that Arch H E is the Line H I.

Diff. 14.

The Verſod Sine of an Arch is that part of the Diameter which lyeth between the right Sine of that Arch and the Circumference, ſo that G E is the Verſod Sine of the Arch H E, and G D, the Verſod Sine of the Arch H A D.

Diff.

Diff. 15.

A Tangent is a Perpendicular let fall upon the Diameter of a Circle, F E being the Tangent of the Arch H E, and C F is the Secant of ſame Arch.

Diff. 16.

A Segment of a Circle is that part of the Circumference that is contained between a Chord or Subtenſe, be it ſmall or great; as that part of the Circumference H E K in the foregoing Figure is a Segment of the whole Circumference E A D B.

Diff. 17.

The Diameter of a Circle is the Line D E, the Semidiameter is the half of that Line, *viz.* D E, or C E, which may be ſuppoſed to be 10. 00. 000. parts, and all the reſt of the other right Lines have their proportion thereunto.

Trigonometrial Diffinitions.

An Explication of ſome Terms and Symbols uſed in Trigonometry.

A Problem is, when ſomething is propoſed to be done or effected.
A Theorem is, when ſomething is propoſed to be demonſtrated.

A Coralary is, a Conſectary, or a Conſequent Truth gained from a preceding Demonſtration.

A Lemma is the Demonſtration of ſome Premiſe, whereby the proof of the thing in hand becomes ſhorter.

Symbols.

= Equal to.
+ More.
— Leſs

Trigonometrical Diffinitions.

— Leſs.

× Drawn into.

:: Proportionality.

Z The Sum.

S Sine.

C S Co-Sine.

Co. Ar. Complement Arithmetical.

T Tangent.

C T Co-Tangent.

2 R Ang. Two right Angles.

Q Square.

Spherical Diffinitions.

THE Circles of the Sphere are ten; ſix greater, and four leſſer, *viz.* The greater Circles are the Horizon, the Meridian, the Equinoxiall, the Ecliptick; the two Colures, one of the Equinox, the other of the Solſtice.

The four leſſer Circles are the two Tropicks, and the two Polar Circles; beſides ſome imaginary Circles in the Sphere; as the Azimuths, Almicauteraths, Parallels of Declination and of Latitude.

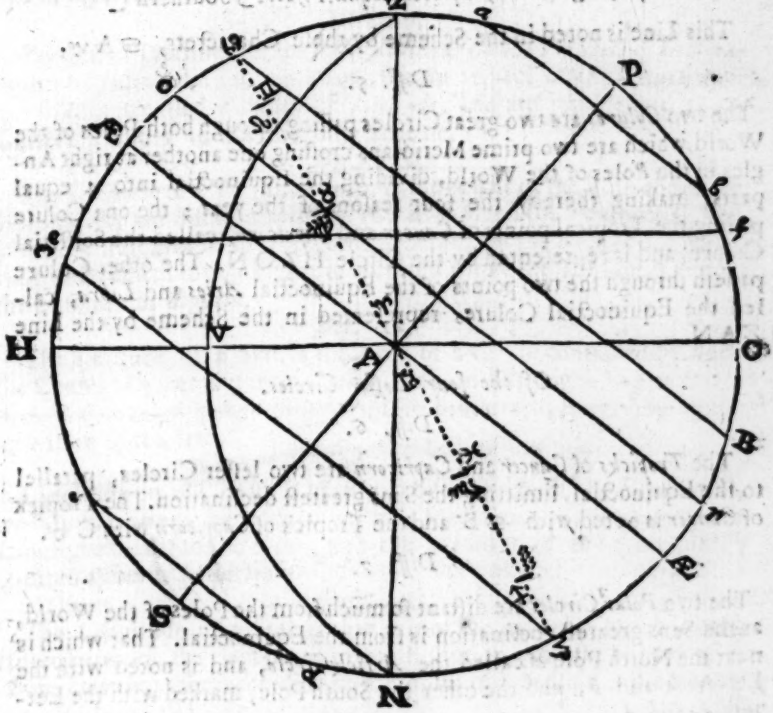
Diff. 1.

The Horizon is a great Circle dividing the ſuperiour Hemiſphere from the inferiour, being every where equi-diſtant from the Zenith, and is repreſented to you in the following Scheme by the Letters, H. A. O.

Diff. 2.

The Meridian is a great Circle paſſing through the Poles of the Zenith

Zenith point, right over our heads, and is represented in the Figure by the Letters H. Z. O. N.



Diff. 3.

The *Equinoctial* is a great Circle that crosseth the Axis of the World at right Angles, and divideth the Sphere into two equal parts and is noted in the Scheme by the Line Æ A Æ.

Diff. 4.

The *Ecliptick* is a great Circle of the Sphere dividing the Equinoctial into two equal parts, by the head of *Aries* and *Libra*; the one half doth decline towards the North, the other towards the South, each way 23d 30′. It is divided into 12 Equal parts called Signes, as,

♈ *Aries*,

♈ ♉ ♊ ♋ ♌ ♍ } Nothern
Aries, Taurus, Gemini, Cancer, Leo, Virgo, } Signes.
♎ ♏ ♐ ♑ ♒ ♓ } Southern
Libra, Scorpio, Sagittarius, Capricor, Aqua. Piſces.

This Line is noted in the Scheme by theſe Characters, ♋ A ♑.

Diff. 5.

The two *Colures* are two great Circles paſſing through both Poles of the World, which are two prime Meridians croſſing one another at right Angles in the Poles of the World, dividing the Equinoctial into 4 equal parts, making thereby the four ſeaſons of the year; the one Colure paſſing the Tropical points of *Cancer* and *Capricorn*, called the Solſtitial Colure, and is repreſented by the Circle H Z O N. The other Colure paſſeth through the two points of the Equinoctial *Aries* and *Libra*, called the Equinoctial Colure, repreſented in the Scheme by the Line Z A N.

Of the four Leſſer Circles.

Diff. 6.

The *Tropicks* of *Cancer* and *Capricorn* are two leſſer Circles, parallel to the Equinoctial, limitting the Suns greateſt declination. The Tropick of *Cancer* is noted with ♋ B and the Tropick of *Capricorn* with C ♑.

Diff. 7.

The two *Polar Circles* are diſtant ſo much from the Poles of the World, as the Suns greateſt declination is from the Equinoctial. That which is near the North Pole is called the *Artick Circle*, and is noted with the Letters *a* and *b*; and the other the South Pole, marked with the Letters *c* and *d*.

Of other Circles that are imagined in the material Sphere.

Such are the *Azimaths*, *Almicanterathes*, *Parallels* of Latitude and Declination.

Diff. 8.

Azimaths are all great Circles biſecting the Sphere, which meet together in the *Zenith*, and may be imagined to paſs through every Degree and minute of the Horizon, and is noted in the Scheme with the Letters Z V N.

Diff.

Def. 9.

Almicanterahs, are Circles parallel to the Horizon, which ſerve to meaſure the altitude of the Sun, Moon and Stars above the Horizon; and is repreſented by the Line *e*, *f* in the foregoing Scheme.

Def. 10.

Parallels of Declination are leſſer Circles, called *Parallels of Declination* in reſpect of the Sun or Stars, but in reſpect of the ſcituation of the Earth are called *Parallels of Latitude*, and are repreſented by the Letters *p* and *r* in the foregoing Scheme.

Def. 11.

The Latitude of a Town or Place, is the height of the Pole above the Horizon, or the diſtance between the *Zenith* and the Equinoctial, and may be repreſented in the foregoing Scheme, by the Arch of the Meridian O P, which in this Figure is elevated above the Horizon $51^d\ 32'$, the Latitude of *London*.

Def. 12.

The Latitude of a Star is the Arch of a Circle contained between the Center of a Star and the *Ecliptick* Line, making right Angles therewith, and counted either Northward or Southward, according to the ſcituation of the Star.

Def. 13.

Longitude on the Earth is meaſured by an Arch, of the Equionxial, contained between the primary or firſt Meridian, of any place where Longitude is aſſigned to begin, and the Meridian of any other place; counted alwayes Eaſterly.

Def. 14.

The Longitude of a Star is that part of the Ecliptick which is contained between the ſtars place in the Ecliptick, and the beginning of *Aries*, counting them according to the order of ſucceſſion of the Signes.

Def. 15.

Altitude of the Sun or Stars, is the Arch of a Circle contained betwixt the Center of the Sun or Star and the Horizon: As for Example, Suppoſe the Sun were on the Meridian at ☉ in the foregoing Figure, then the Angle of Altitude will be the Angle ☉ A H, the meaſure thereof will be the Arch ☉ H, contained betwixt the Sun at ☉ and the Horizon H, which is 62 Degrees, the height of the Sun at Noon, when he is in the Tropick of *Cancer*.

Def. 16.

Aſcenſion is the riſing of any Star, or any part or portion of the Equinoctial above the *Horizon*.

Def. 17.

Right *Aſcenſion* is the number of Degrees and Minutes of the Equinoxial (counted from the beginning of *Aries*) which cometh to the Meridian with the Sun or Stars, or any portion of the Ecliptick.

Def. 18.

Oblique Aſcenſion, is an Arch of the Equinoctial between the beginning of *Aries*, and that part of the Equinoctial that riſeth with the Center of a Star or any portion of the Ecliptick in an Oblique Sphere.

Def. 19.

Aſcenſional Difference, is an Arch of Difference between the right Aſcenſion, and the Oblique Aſcenſion; or it is the number of degrees, contained between that place of the Equinoctial that riſeth with the center of a Star, and that place of the Equinoctial that cometh to the Meridian with the Center of the ſaid Star.

Def. 20.

The *Poles* of the Word are two points that are diametrically oppoſite one to another, the one is called the Artick, the other the Antartick Pole; the North being noted in the fore-going Scheme with the Letter P, and the Antartick with the Letter S.

Def. 21.

The *Axis* of the World is a Line imagined to be drawn from each Pole noted with the Letters P A S.

Def. 22.

The Poles of the Ecliptick are two points Diametrically oppoſite one to another diſtant from the North and South Poles of the World, 23 Degrees 32 Minutes.

Def. 23.

The *Zenith* is an imaginary Point in the Heavens right over our heads, making 90 degrees with the Horizon, noted in the fore-going Scheme with the Letter Z.

Def. 24.

The *Nadir* is an imaginary point in the Heavens, right under our feet, diametrically oppoſite to the *Zenith*, noted in the fore-going Scheme with the Letter N.

Def. 24.

The true Amplitude of the Sun is the wideneſs or diſtance of the riſing or ſetting thereof, from the true Eaſt or Weſt point of the Horizon, reckoned in Degrees and Minutes.

Def.

Def. 26.

Magnetical Amplitude of the Sun, is the distance of the rising or setting of the Sun from the East or West point reckoned in Degrees and Minutes.

Def. 27.

The *Zodiack* is a great Circle of the Sphere, like unto a broad Hoop or Cirdle, 12 degrees in breadth, 6 degrees on each side of the Ecliptick Line, wherein are placed the 12 Signs, having each of them 30 degrees, in which the Planets do alwayes move; according to the *Ptolomean* Hipothesis.

Astronomical Definitions.

Def. 1.

A *Cronical* rising of a Star is when the Star riseth at the same time the Sun setteth; *A cronical* setting is when the Star goeth down beneath the Horizon with the Sun.

Def. 2.

Cosmical or worldly rising of a Star is when it riseth with the Sun.

Def. 3.

The *Heliacal* rising of a Star is to be understood of those that have been obscured with the Sun-Beams, and the Sun moving with the succession of the Signes. The Star begins at the Sun-rising a little before the Sun. The *Heliacal* setting is when any Star is seen presently after the Sun-setting; and a few dayes after will be obscured with the glory of the Sun-Beams.

Def. 4.

The *Culminating* of a Star is when the Star cometh just upon the Meridian.

Def. 5.

Circles of position pass by the common Sections of the Meridian and by the Center of a Star.

Def. 6.

A *Constellation* or *Asterism* is a certain number of Stars gathered together into one Form, representing the form of some Creature or thing, whereby they are particularly known to all the World, which the antient Astronomers did devise that they might be brought into rule and order for the help of memory.

Of these Constellations there are 60 in number, 21 being in the North, 12 in the *Zodiack*, and 27 in the South.

The Names and Number of the Stars of each Constellation.

Northern Constellations are 21, viz.

1 *Ursa Major.*	7	12 *Heniochus* or *Auriga.*	14
2 *Ursa Minor.*	27	13 *Serpentarius.*	24
3 *Draco.*	31	14 *Serpens.*	18
4 *Cephus.*	11	15 *Sagittarius.*	5
5 *Bootes*, or *Arctophilax.*	22	16 *Aquila.*	9
6 *Corona Borealis.*	8	17 *Delphinus.*	10
7 *Engonases*, aut *Hercules.*	29	18 *Equulus.*	4
8 *Lyra.*	10	19 *Pegasus.*	20
9 *Olor* aut *Avis.*	17	20 *Andromeda.*	23
10 *Cassiopea.*	13	21 *Triangulus.*	4
11 *Perseus.*	26.		323

Zodiack Constellations, 12. *viz.*

1 *Aries.*	13	7 *Libra.*	8
2 *Taurus.*	23	8 *Scorpio.*	21
3 *Gemini.*	18	9 *Sagitarius.*	31
4 *Cancer.*	9	10 *Capricornus.*	28
5 *Leo.*	27	11 *Aquarius.*	42
6 *Virgo.*	26	12 *Pisces.*	34
			280

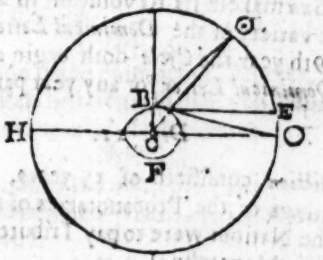
Southern

Southern Constellations, 27.

1	*Cetus.*	22	15	*Pisces Notius.*	11
2	*Orion.*	31	16	*Grus.*	13
3	*Flumen Eridanus.*	34	17	*Phœnix.*	15
4	*Lupus.*	12	18	*Indus.*	12
5	*Canis Major.*	18	19	*Pavo.*	23
6	*Canis Minor, vel canicula.*	2	20	*Apus avis Indica.*	11
7	*Argo Navis.*	41	21	*Apisc. Musca.*	4
8	*Hydra.*	25	22	*Chamelion.*	10
9	*Crater.*	7	23	*Triangulum Auster.*	5
10	*Corvus.*	7	24	*Pisces volans Passer.*	7
11	*Centaurus.*	37	25	*Dorado Xiphias.*	7
12	*Fera aut Lupus.*	19	26	*Toucan Anser Americanus.*	8
13	*Ara vel altar.*	7	27	*Hydrus.*	21
14	*Corona Austr. vel Merid.*	10			
					429

Def. 7.

Paralax is an Angle made by the Semidiameter of the Earth and the Horizon and also of the Sun or Moon, as may be more plainly Illustrated by this annexed Figure,



The Letters **BF** represent the Body of the Earth, **C** the Center, **BC** the Semidiameter thereof: so that you may hereby see apparently, that there is a sensible Angle made from the edge of the true Horizon,

zon, and the Semidiameter of the Earth noted by the Angle B O C, or E B O, and the higher the Sun is, the leſſer is the Paralactical Angle, as you may ſee in the Figure, ſuppoſing the Sun to be at the point ⊙; where alſo it is apparent that there is a ſenſible Angle made by the Center of the Earth and the Superficies, but not ſo great at that is at the Horizon, ſo that you may from hence conclude, that the higher the Sun is, the leſs is the Paralactical Angle; ſo that in any Obſervations that are made of the Suns Altitude, there ought to be regard had thereto, for it doth repteſent the Sun lower than indeed it is.

Def. 8.

Refraction is that which is cauſed by reaſon of the Vaporous thickneſs of the Air betwixt us and the heavenly Lights, which maketh the Sun or Stars to appear higher than in reallity they are, eſpecially when they are near the Horizon; for which there ought to be conſideration had in ſeveral Obſervations, as ſhall be afterwards made appear by the Tables of Paralax and Refraction following, and may plainly be demonſtrated by a ſtrait ſtick being put into water, the lower end thereof ſhall appear higher than in reality it is, and ſhall ſhew as if it were broken.

Def. 9.

The *Golden Number* or *Prime*, is a circular revolution of 19 Years, in which tearm of years it hath been antiently ſuppoſed that the Sun and Moon doth make all their variety of their Aſpects one to another.

Def. 10.

The *Cycle of the Sun* maketh its Revolution in 28 years, becauſe that in that time all the variety of the *Dominical Letters* and *Leap-Years* are expired, and the 29th year the *Cycle* doth begin again; which number is to find out the *Dominical Letter* for any year paſt, preſent, or to come.

Def. 11.

The *Roman Indiction* conſiſteth of 15 years, and is ſet down in the Charters and Writings of the Protonotaries of the Pope of *Rome*; for once in 15 years the Nations were to pay Tribute to the *Romans* (thoſe that were under their Monarchy.)

Def. 12.

The *Epact* is a number never exceeding 30 dayes, but is the 11 dayes and

and 6 hours, which added to the Lunar year being 354 dayes doth make it equal to the Solar year, which is 365 dayes.

Def. 13.

The *Leap-Year* is every fourth year, which hath a day more in it than another year hath, which day is made up in four years by the odd ſix hours that is over and above 365 dayes; which day is alwayes added at the end of *February*; ſo that *February* hath every *Leap-Year* 29 dayes, and in it are alwayes two *Dominical Letters*; the firſt ſerving from the firſt of *January*, until the 25 of *February*, and then the other Letter takes place and ſerves to the years end. And here note that the *Prime* and *Dominical Letter*, and the *Cycle of the Sun*, changeth the firſt of *January*, and the *Epact* the firſt day of *March*; the *Number of Direction* the 22 of *March*, and the *Roman Indiction* the firſt of *September*.

Nautical Definitions.

Def. 1.

THat which is commonly called the Courſe, is the Point of the Compaſs upon which you Sail, being reckoned from the Meridian, from the North or South, either Eaſterly or Weſterly.

Def. 2.

The Complement of the Courſe is the Number of Rhombes or Degrees, reckoned from the Eaſt or Weſt, Northerly or Southerly.

Def. 3.

The Diſtance upon the Courſe, is the quantity of Leagues or Miles that you Sail upon that Courſe.

Def. 4.

Difference of Latitude is the Number of Degrees, Leagues, or Miles contained betwixt the Parallel from whence you departed, and the Parallel you now are in, reckoned in the Meridian.

Def. 5.

Difference of Longitude is the number of Leagues and Miles that you are ſeparated from the Meridian where you firſt were, unto the place where you are now arrived.

Def. 6.

The Variation of the Compaſs is an Arch of the Horizon, interpoſed between the true Meridian and the Magnetical either Eaſterly or Weſterly.

Gco-

Geographical Definitions.

Def. 1.

THE Globe of the Earth is a Spherical Body proportionally composed of Earth and Water, and is divided into Continents and Islands.

Def. 2.

A Continent is a great quantity of Land not divided nor separated by the Sea, wherein are many Kingdoms and Principalities, as *Europe*, *Asia*, and *Africa* are one Continent, and *America* is another.

Def. 3.

An Island is such a part of the Earth that is invironed round with Water; as the Island of *England*, and *Scotland*, and also *Ireland*, and the Isle of *Wight*, and the *Barbadoes*, *&c.*

Def. 4.

A Peninsula is such a part of Land which is almost compassed about with water, and is only joyned with the Land by an Isthmus; such is that great part of Land in *America*, called *Peruviana* and *Morea*, in the *Levant*.

Def. 5.

An *Isthmus* is a narrow neck of Land which joyneth the Peninsula to the Continent.

Def. 6.

A Promontary is some high Mountain, or great Cape of Land that shooteth it self into the Sea, as *Cape Bon Esperance*, or *Capo de Verde* in *Africa*.

Def. 7.

The Ocean is a general Collection of the Waters, which invironeth the whole world on every side.

Def. 8.

The Sea is a part of the Ocean to which we cannot come but through some streight, as the *Mediterranean* and the *Baltick* Sea.

Def. 9.

A Straight is a part of the Ocean restrained within narrow bounds and opening away to the Sea, as the Straits of *Gibralter* that leadeth into the *Mediterranean* and the *Sound* that leadeth into the *Baltick* Sea.

Def. 10.

A Creek is a ſmall narrow part of the Sea or Rivers, that goeth up a little way into the Land.

Def. 11.

A Bay is a great Inlet of the Land, as the Bay of *Biſcaia*, and the Bay of *Mexico*.

Def. 12.

A Gulph is a greater Inlet of the Land deeper than a Bay, ſuch is the Gulph of *Venice*, and the Gulph of *Florida*, which alſo hath a ſwift Current.

Def. 13.

A Climate is a certain ſpace of Earth and Sea that is included within the ſpace of two Parrallels, and of them there hath been antiently accounted ſeven.

1. *Dia Meroes.*
2. *Dia Syenes.*
3. *Dia Alexandrias.*
4. *Dia Rhodes.*
5. *Dia Rhomes.*
6. *Dia Boriſthenes.*
7. *Dia Ripheos.*

Def. 14.

A *Zone* is a certain ſpace of Earth contained between certain Circles of the Sphere, and are thus divided.

The Heaven and Earth is divided into five *Zones*, *viz.* One Torrid or Burning *Zone*, two Temperate, and two Frozen *Zones*.

The Torrid *Zone* is that which is on each ſide the Equinoctial bounded by the Tropicks of *Cancer* and *Capricorn*.

The two temperate *Zones* are contained between each Tropick and the Polar Circles.

The two Frigid or Frozen *Zones* are contained within each Polar Circle and their reſpective Poles.

Of the Division of the Earthly Globe.

The Globe of the Earth is divided into four parts, *viz.*

Europe } { *Africa* and
Asia } { *America.*

Europe is bounded from *Asia* by the *Mediterranean Sea*, on the East with the River *Tanais*, and on the West with the Western Ocean; and containeth these Provinces.

Germany, *Spaine*, *Swedeland*, *Hungaria*,
Italy, *Denmarke*, *Muscovia*, *Slavonia*,
France, *Norway*, *Polonia*, *Grecia.*

The Principal Islands are these:

Great Brittain, *Candia*, *Sardinia*,
Ireland, *Scicilia*, *Corsica*, *Cyprus.*

Asia is Bounded on the North with the North Ocean, on the South with the Red Sea, on the East with the East-Indian Ocean, and on the West with the Flood *Tanais*. The Principal Regions are

Anatolio, *Armenia*, *Assyria*, *Persia*, *China*,
Syria, *Arabia*, *Mesopotamia*, *Parthia*, *India*,
Palestina, *Media*, *Chaldea*, *Tartaria*, and the Islands thereof.

Africa is Bounded on the East with the Red Sea, on the West with the *Atlantick* Ocean, and on the South with the Southern Ocean, and on the North with the *Mediterranean* Sea.

The Provinces are,

Egypt, *Barbaria*, *Æthiopia*,
Abassines, *Alonomotopa.* *Nuba*,

The Islands are,

Madagascar, or St. *Laurence*, St. *Thomas*, *Insula de Cape Verde*,
Insula de Canaria, *Insula de Madera.*

America

America is bounded on the East with the *Atlantick Ocean*, on the West with the West-Indian Ocean, on the North with the Northern Ocean, on the South with the *Magilanick* Sea.

It Conſiſts of two Principal parts, *viz. Mexicana*, *Peruana*.

The Provinces of *Mexicana* are,

Nova Hiſpania, *Terra Florida*, *Nova Francia*,
Calaformia, *Nova Albion, vel Anglia*, *Eſtotilant*.

The Provinces of *Peruana*, are,

Brazilla, *Tiſnada*, *Caribana*, *Catagena*, *Peru*,
Charah, *Chila*, *Chicha*, *Patagonos*.

The Chief Iſlands of *Mexicana* are,
Iſland, *Fritzland*, *Greenland*.

The Chief Iſlands of *Peruana* are,

Hiſpaniola, *Cuba*, *Jamaica*, *Porto Rico*, *Barbadoes*, and all the reſt of the *Cariba* Iſlands; *Inſula Margaretta*, *Molucque Inſul. Remores*, *Java Major*, *Java Minor*, *Salamonis Inſula*. All other Iſlands in *India Orientalis*.

The Names of the Seas.

Ocean Sea, *Narrow Sea*, *Mediterranean Sea*, *Mare Majore*, *Mare Pacificum*, *Mare Caſpium*, *Eaſt-Indian Sea*, *Perſian Sea*, *Red Sea*, *Mar Del Zur*.

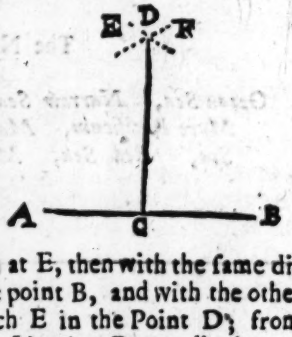
Geometrical Rudiments.

CHAP. II.

Containing ſome neceſſary Rudiments in Geometry, with the Geometrical Projection and Fundamental Demonſtration of ſeveral Lines placed on the Plain Scale, with ſome other additional Lines very uſeful in the protraction of ſeveral Propoſitions in Geometry, Aſtronomy, and Navigation.

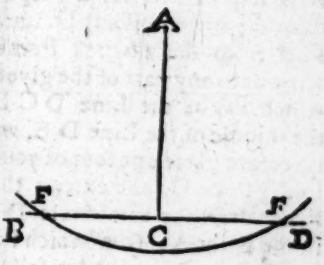
How to raiſe a Perpendicular from the middle of a Line given.

LET the Line given be A B, and let C be a point therein whereon it is required to raiſe a Perpendicular. Firſt therefore, open the Compaſſes to any convenient diſtance, and ſetting one foot in the Point C, with the other foot mark on either ſide thereof the equal diſtances C A and C B; Then opening the Compaſſes to any convenient wider diſtance ſetting one foot in the point A, with the other ſtrike the ſmall occult Arch at E, then with the ſame diſtance of the Compaſſes ſet one foot in the point B, and with the other draw the Arch Line F, croſſing the Arch E in the Point D; from which Point D, draw the Line D C, which Line is a Perpendicular unto the given Line A B as was required.



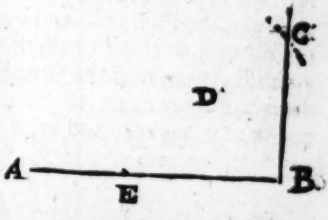
To

To let a Perpendicular fall from a Point aſſigned to the middle of a Line given.



Let the Line given whereupon you would have a perpendicular let fall, be the Line B C D, and the Point A to be the Point aſſigned from whence you would have a Perpendicular let fall upon the given Line B C D. Firſt ſet one foot of your Compaſſes in the Point C, and opening your Compaſſes to any convenient diſtance, ſo that it be more than to the Line A C. Make an Arch of a Circle with the other foot, ſo that it may cut the Line B C D twice, that is, at E and F; then find the middle between theſe, which will be the Point C, from which Point draw the Line A C, which is the Perpendicular which was to be let fall.

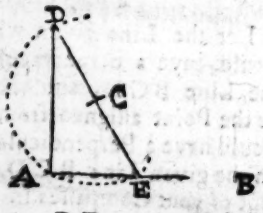
To raiſe a Perpendicular upon the end of a Line given.



Suppoſe the Line whereupon you would have a Perpendicular raiſed, be the Line AB; Firſt open your Compaſſes to a convenient diſtance, and ſet one foot in the Point B, and let the other Point fall any where, as at the point D; and in that point let the foot of your Compaſſes remain, turning the other foot about, until the other foot do touch the Line A B in the Point E; then turn the ſame foot of the Compaſſes toward C, and draw a ſmall occult Arch, then lay the edge of a Ruler to thoſe two Points E and D, and where the ſame edge of the Ruler doth cut the Arch C from that very point of interſection, draw the Line C B, which ſhall be a true Perpendicular at the end of the Line A B.

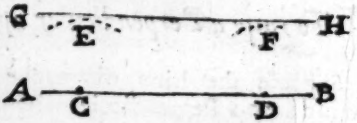
To

To let fall a Perpendicular from a Point assigned unto the end of a Line Given.



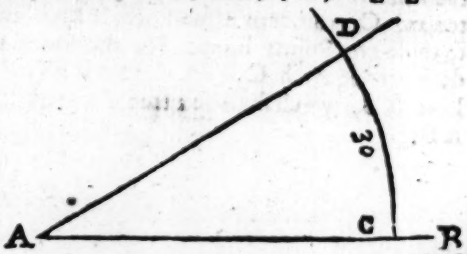
Let the Line A B be given, unto which it is required to let a Perpendicular fall from the assigned Point D, unto the end A. First from the assigned Point D, draw a Line unto any part of the given Line A B, which may be the Line D C E, then find the middle of the Line D E, which is at C, therefore place one foot of your Compasses in the Point C, and extend the other foot unto D E, with which distance draw the Semicircle D A E, so shall it cut the given Line A B in the Point A; from which Point A, draw the Line D A, which shall be the Perpendicular let fall from the assigned point D unto the end A of the given Line A B, as was required.

To draw a Line Parallel to a Line given.



Let A B be a Line given, whereunto it is required to draw a Parallel. First set one foot of your Compasses in the Point C, and opening the other foot at pleasure, draw the Arch E; then with the same distance set one foot in the Point D, and draw the other small Arch F; Lastly, lay a Rule to the Convexities of both those Arches, and draw the Line G H, which shall be a Parallel to A B, as was required.

By the help of a Line of Chords and a Pair of Compasses to make an Angle containing any Degrees assigned, or to know the quantity of any Angle given.

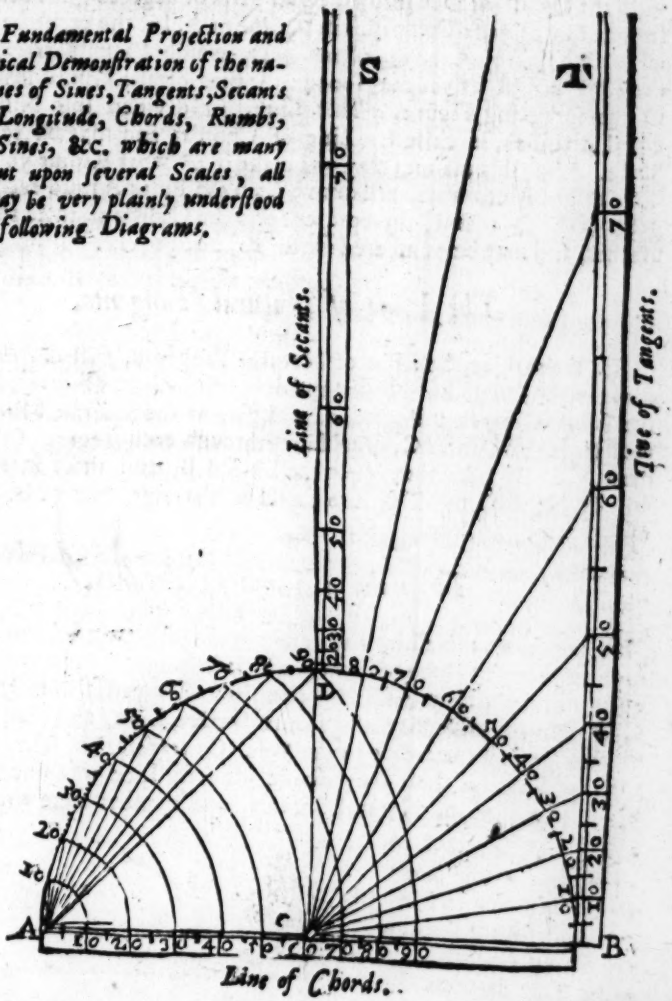


First therefore for the making of an Angle of any quantity assigned, open your Compasses to the Radius of your Scale to 60 Degrees, and setting one foot thereof in the Point A, with the other foot describe the

Arch

Arch D C, then draw the Line A C B, then open your Compaſſes to ſo many Degrees as you pleaſe upon the Line of Chords; ſuppoſe 35 Degrees, that extent ſet off from C to D, where at D make a mark with your Compaſſes, and from that Point C, draw the Line A C, which ſhall make the Angle D A C.

The Fundamental Projection and Geometrical Demonſtration of the natural Lines of Sines, Tangents, Secants Line of Longitude, Chords, Rumbs, Verſed Sines, &c. which are many times put upon ſeveral Scales, all which may be very plainly underſtood by theſe following Diagrams.



For

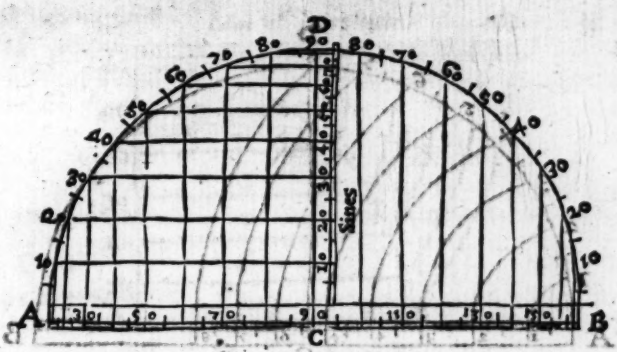
For the Fundamental Demonſtration and Diviſion of the Line of Chords, you muſt firſt draw the Diameter A C B in the foregoing Scheme, and upon the Center C deſcribe the Semicircle A D B; which Semicircle divide into two equal Quadrants by the Point D, then divide the Quadrant D A into 90 equal parts or degrees; this being done ſet one foot of your Compaſſes in the Point A, let the other be extended to each degree of the Quadrant A D, which Extents transfer unto the Line A C B as you may ſee the Arches of the Circle lead to, as in the foregoing Figure. This Line, ſo divided into Ninety unequal diviſions, is called a Line of Chords, and may be ſet on any Scale. After this manner may you make it of what Radius you pleaſe. Thoſe right Lines which are drawn from the Point A unto each ten degrees of the Quadrant, do repreſent alſo the Chords of thoſe reſpective Arches, and may be numbered with 10, 20, 30, *&c.*

The Line *of Natural Tangents.*

For the making the Line of Natural Tangents, firſt draw the Quadrant in the foregoing Scheme, and divide it into 90 Degrees, and from the Point B erect a Perpedicular Line, as the innermoſt Line T B; then from the Center C, draw Lines through each degree of the Quadrant C D B, until they touch the Line T B, and thoſe interſections will divide the Line T B into a natural Tangent, and to be numbred with 10, 20, 30, *&c.*

To make a Line *of Secants.*

Having drawn thoſe Lines aforeſaid in the foregoing Scheme (through each reſpective degree of the Quadrant as before) from the Center C until they touch the Line T B, extend your Compaſſes from the Center C to the very extremity of each reſpective Line, and the foot of the Compaſſes ſtill remaining in the Point C, transfer the ſaid Lines unto the Line D S, ſo ſhall they divide the ſaid Line into unequal parts, which is a Line of Natural Secants, and number them with 10, 20, 30, *&c.*



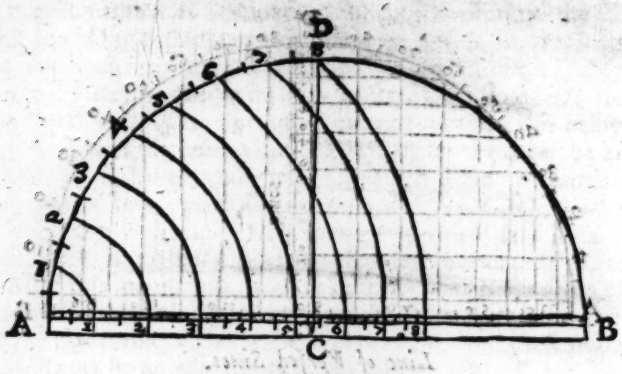
Line of Verſed Sines.

Of the Line of Right Sines.

The Fundamental demonſtration of the Line of Sines is thus to be performed; Firſt draw the Line A C B and upon C deſcribe a Semicircle, and one of the Quadrants divide into 90 degrees as the Quadrant A D C, then draw a Line through each tenth degree of the Quadrant parallel to the Line A C B, it will divide the Line D C into 90 unequal parts, which will be a Line of Natural Sines, and to be numbred from C towards D, with 10, 20, 30, *&c.* unto 90.

Of the Line of Verſed Sines.

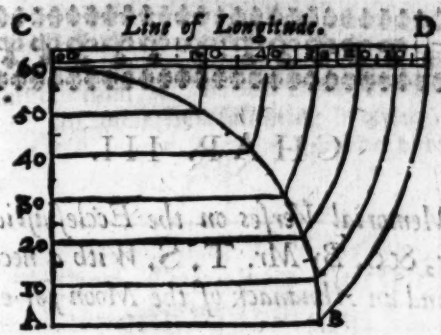
For the Geometrical Projection and Demonſtration of the Line of Verſed Sines, it is thus to be effected; Firſt draw the Line A C B, and upon C draw the Semicircle A D B, which divide into 180 Degrees, then drawing right Lines parallel to the Line D C, they will divide the Line A B into 180 unequal parts, which will be a natural Line of Verſed Sines, and to be numbred with 10, 20, 30, 40, *&c.* unto 180.



Line of Rhombes.

The Fundamental Projection and Demonstration of the Line of Rhombes.

For the dividing of the Line of Rhombs, First draw the Line A C B, and upon the Point C describe the Semicircle A D B, and divide the Quadrant A B into 8 equal parts; which being done, set one foot of your Compasses in the Point A, and with the other foot extend to each of those divisions, and transfer those extents unto the Line A C B, which will divide the said Line into eight unequal parts, which will be a Line of Rhombs and to be numbred with 1, 2, 3, 4, &c. unto 8.



The Geometrical Demonstration of the Line of Longitude.

First draw the Quadrant C A B, and divide the side C A into 60 equal parts; then through each of those equal parts, draw Lines Parallel to the side A B, until they touch the Quadrant C B; which being done, set one foot of your Compasses in the Point C, and extend the other foot unto each respective Point of intersection in the Quadrant C B; and then transfer them unto the Line C D (which is to be the distance between C and B, or the Chord of ninety degrees) so shall those Intersections divide the Line C D into 60 unequal parts, which is called the *Line of Longitude.*

These Natural Lines being all expresst upon a Scale, serve for many necessary conveniencies in the Geometrical Projection of several Nautical and Astronomical Questions.

As for other Lines which are artificial (as the Lines of Numbers, Sines, Tangents, &c. that are commonly inscribed on *Gunters* Rulres) they are projected from the Artificial Tables of Logarithms, Sines, Tangents, *&c.* and so inserted on such Rulres by the help of a Diagonal Scale and a pair of Compasses.

CHAP. III.

Containing Memorial Verſes on the Eccleſiaſtical and Civil Kalender, &c. By Mr. T. S. With a neceſſary Tyde-Table, and an Almanack of the Moon for eight years.

To know if it be Leap-Year.

Divide the Year by 4; What's left ſhall be
For Leap-Year 0, for paſt 1, 2, or 3.

HEre you may omit the Hundreds and alſo the Twenties of the Year of the Lord; and only divide the reſidue by 4.

For Example.

Anno 1667. omitting the Hundreds and alſo the 3 Scores, I divide the Reſidue, which is 7, by 4; and there remaineth 3, which ſhews it is the Third after Leap-Year.

To find the Dominical-Letter.

Divide the Year, its 4th, and 4, by 7;
What's left ſubſtract from 7; the Letter's given.
A 1. B 2. C 3. D 4. E 5. F 6. G 7.

Example.

Of the Year of Chriſt	1667
The 4th part (omitting fraction) is	416
To both which I add the number	4
The Sum is	2087,

which divided by 7, there is left 1, which ſubſtracted from 7, the laſt remainer

remainer 6, ſhews that the Dominical Letter for the Year 1667 is the 6th in order of the Alphabet, that is F.

But the Leap-year hath two Dominical Letters: The Latter found by this Rule, ſerveth from St. *Matthias* Day to the Years End; and for finding *Eaſter*. The former next following in order from A to G, and beginning again at A, ſerveth from the *New-Year* unto St. *Matthias*.

For the Golden-Number, Cycle of the Sun, and Indiction.

When 1, 9, 3, to th' Year hath added been;
Divide by 19, 28, 15.

Example.

To 1667, I Add 1, the ſum 1668 I divide by 19, and there remaineth 15, which is the *Golden Number* for the Year 1667.

Again, to 1667, I add 9, and the ſum 1676 I divide by 28, the reſidue 24 is the *Cycle of the Sun* Anno 1667.

Laſtly, to 1667, I Add 3, the ſum 1670 divided by 15, the remainer 5 is the *Indiction* for 1667.

The Prime or Golden Number being given; To find the Epact.

Divide by 3; for each one left add 10;
30 reject: the Prime makes Epact then.

Example.

Anno 1667, The Golden Number 15 I divide by 3, and there is left 0; therefore ten times 0, which is 0, added to 15, the ſum is 15, the *Epact Anno* 1667.

By

By the 19 Epacts, to find the Day of Eaſter-Limit from the beginning of March inclusively.

The Epacts take from 47; but two
The greateſt take from 77: 'twill do.

Example.

Anno 1667. The Epact being 15, I ſubſtract it from 47, and the reſidue 32 is *Eaſter-Limit*, Anno 1667. that is *April* 1. reckoned from the beginning of *March* inclusively.

But when the Epact is 28 or 29, it muſt be ſubſtracted from 77, that ſo the Limit may remain. And the next following Sunday after the Limit is alwayes Eaſter-day.

Eaſter-Limit, and the Dominical Letter being given; To find Eaſter-Day.

The Letter more by 4 from Limit take;
What's left from neareſt Sevens ſhall Eaſter make.

Or thus,

Take the Number of the given Letter more by 4 from the given Limit, and the reſidue from the neareſt greater ſum of Sevens: the laſt remainer added to the Limit; the Sum or its exceſs above 31, is Eaſter-Day in *March* or *April*.

Example.

Anno 1667. The Letter 6 more by 4, is 10, which taken from the Limit 32, the Reſidue is 22; this taken from the neareſt greater Sum of Sevens, 28, there remaineth 6, which added to the Limit 32, the Sum is 38, the exceſs of which above 31, is 7. Therefore the 7th of *April*, *Anno* 1667, is Eaſter-Day.

For

For the Dayes of the Months on which ☉ entereth the 12 Signs.

Twice 9, *twice* 10, 4 *Twelves*, 11,
Then 10, *then* 9, *then* 8 *or* 7.

Anno 1700. ☉ in

♈.	♉.	♊.	♋.	♌.	♍.	♎.	♏.	♐.	♑.	♒.	♓.
Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
9.	9.	10.	10.	12.	12.	12.	12.	11.	10.	9.	8.

For the Degree of the Suns Place on any Day.

From the Day of the Month on which the Suns Place is required, if you may, or elſe from the ſum of that and 30, ſubſtract the day of his enterance into the Sign of that Month; the remainer ſhall be the Degree of his Place in that or the next preceding Sign.

For the Age of the Moon, or Day of Change.

Janus 0, 2, 1, 2, 3, 4, 5, 6,
8, 8, 10, 10, *theſe to the Epact fix*:
The ſum (*bate* 30) *to the Month Day add*;
Or take from 30: *Age*; *or Change is had.*

Or thus, Add to the Epact, in

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
0.	2.	1.	2.	3.	4.	5.	6.	8.	8.	10.	10.

The Sum, if it be leſs than 30; or elſe, the Exceſs above 30; Added to the day of the given Month (rejecting 30 if need be) gives the Age of the Moon that day; but ſubſtracted from 30, leave the day of the Change in (or from the beginning of) that Month.

For the Day of the Full-Moon; Add or Subſtract 15, to or from the day of the Change.

Example.

(1) For the *Age* of the *Moon*, *Anno* 1687. *May* 29th. The Number for the Month 3, added to the Epact 15, makes 18, which added to 29 (rejecting 30 from the ſum) gives 17, the *Age* of the *Moon* required.

(2) For

(2) For the day of the *Change* (or *New-Moon*) in *May* 1667. The Epact 15 with the Month 3, makes 18, (as afore) which ſubſtracted from 30, the reſidue 12 is the day of the *New-Moon* in *May*, 1667.

(3) The ſum of 12 and 15, is 27, the day of the *Full-Moon* in *May*, 1667.

To find the Day of the New-Moon, and the Entrance of the Sun into the Signes, for Time Paſt or to Come.

312, 131,

Paſt Add, to Come Subſtract; for Moon and Sun.

Or thus.

For every 312 years Paſt, Add 1 day to the time of the New-Moon, found as above: For 312 years to Come, Subſtract 1 day.

Likewiſe, for 131 years paſt, a day is to be Added to the former account of the Suns Entrance; And for 131 years to Come, Subſtracted.

To find the Diſtance of the Sun from the Nodes of the Moon perpetually in all Lunations; Remember,

Year 17 *hundred, Node, Sine* 4, *Degree*

27, 3, 800, 43.

1. Take the Interval between the given time and 1700 Compleat, in years and dayes; allowing 12 Months to the Year, and 30 dayes to a Month: and the account will ſuffice for this work.

2. Multiply the years of the Interval by 43, and divide the Product by 800: the Reſidue multiply by 9; then take the half of this Product and diſtinguiſh the laſt figure from the reſt by a Point. So have you the degrees and 10th parts of a degree anſwerable to the years of Interval.

Alſo, Multiply the dayes of the Interval by 43, and divide by 800: this

Quotient

Quotient shews the degrees, and the remainer divided by 80, the 10th parts of a degree of the Motion for the dayes of the Interval. Then Collect the former and latter degrees and 10ths into one sum, and reduce it into Signs, Degrees and 10ths.

3. For time afore 1700 Compleat, Add the Signs, Degrees and Tenths, thus found to 4s, 27°, 3 tenths; but for time after 1700 Compleat, Substract them from 4s, 27°, 3: and the Sum or Remainer shall be for the place of ☊; Adding one degree for the 10ths if they exceed 5, else rejecting them.

Alwayes in Additions, omit Cycles (to wit, 12s, or 360°.) But in Substractions, add one Cycle if need be, to the Number from which you are to substract.

Next, by the Common rule for 1700, without any correction for time past or to come, find the Sign and Degree of the Suns place, and substract the last found place of ☊ from it: The residue is the Distance of ☉ from ☊ required.

The Limits of Eclipses of the Sun and Moon, in Degrees from ☊ or ☋.

Within 16 the Sun, and 10 the Moone.
Suffer Eclipse; Above 18, 12, none.

To find the Length of the Dayes and Nighes in the Lat. of 52°, for ever.

To 15; 1; 1, 16; 2, 6; 3;
1; 2; 3; 4 hours; 4 and half agree.

To the given distances of the Sun from the next Æquinoctial point, the answerable hours are these; to 15°, 1 hour; to 1 Sign, 2 hours; to 1s, 16°, 3 hours; to 2s, 6°, 4 hours; and to 3 Signs 4 hours and an half: which hours added to 12, the sum is from the Vernal Æquinox to the Autumnal, the just length of the Day, but from the Autumnal to the Vernal the length of the Night in those Distances.

And for all other intermediate diſtances of ☉ from the Æquinoctial points; the Proportion is; As 15, 16 or 20°, to 60′; or as 29° to 30′; So are the degrees of the exceſs of the intermediate diſtances above 0°, 15°, 1°, 1′, 16°, or 2° 6°, and not exceeding 2° 26°, to the minutes of the Length of the Day or Night above 12, 13, 14, 15 or 16 houres: Always allowing 4 Degrees or Dayes afore and after the Ingreſs into ♋ and ♑ for Solſtice.

The Length of the Day and Night taken together is 24 hours, from which if the one be ſubſtracted, there will remain the other; And,

Half the Length of the { Night / Day } is the time of { Sun Riſing, / Sun Setting.

To find the Hour of the Moons coming to South; and High-Water at London.

The Moons Age Multiply by 4; Divide
By 5 for Southing: Add 3 for the Tyde.

But when the Age of ☽ exceeds 15 dayes, you may reject 15, As in this Example.

Anno 1667 *May* the 29th. the Age of ☽ being 17 Dayes, I reject 15, and the reſidue 2 multiplied by 4 makes 8, which divided by 5, the Quotient is 1, ⅗, the hour of ☽ Southing; to which I add 3h. and the Sum is, 4. ⅗. or 4h. 36′. the time of Full-Sea at *London*.

But it is here to be noted, that by manifeſt experience it is found, that when the Moon is in either of the Quarters, that then the Tides do not hold out their full time, but is High Water ſooner then is found by the Rule, which may partly be occaſioned by the weakneſs of the Tide at ſuch a time and the length of the River; for by the fore-going Rule you may find, That when the Moon is 7 Dayes old, the time of High-Water will be at 9 of the Clock, when upon true obſervation it will be found to be an hour ſooner; and therefore to know the true time of High-Water you muſt ſubſtract ſome minutes from the time found by the precedent Rule, according to the Age of the Moon, as you may plainly ſee in this annexed Table.

The

The Moons Age					H	M
1	14	16	29	Subſtract.	0	0
2	13	17	28		0	5
3	12	18	27		0	10
4	11	19	26		0	20
5	10	20	25		0	30
6	9	21	24		0	45
7	8	22	23		1	00

Example.

The Moon being 7 dayes Old it is high Tide (by the Rule) at *London* at 9 of the Clock; then in this Table look for the figure 7, which is in the firſt Column, and right againſt it in the two laſt Columns under the Title of Hour and Minute, you will find one hour, which muſt by ſubſtracted from the hour found by the Rule and the remainer is 8, the true time of high water.

A Table ſhewing the time of the Moons coming to South any Day of her Age.

Moons Age.		Moons South.	
0	0	0	0
1	16	0	48
2	17	1	36
3	18	2	24
4	19	3	12
5	20	4	00
6	21	4	48
7	22	5	36
8	23	6	24
9	24	7	12
10	25	8	00
11	26	8	48
12	27	9	36
13	28	10	24
14	29	11	12
15	30	12	00

The uſe of the Table to find the time of the Moons coming to South. The firſt and ſecond Column ſheweth the Dayes of the Moons Age; in the third and fourth the hour and minute of the Moons coming to South.

Example.

The Moon being 10 dayes old, I would know at what time the Moon will be at full South; I find 10 under the Title of the Moons Age in the firſt Column, and right againſt it in the third and fourth Columns, you have 8 hours 00 Minutes, which ſheweth that the Moon being 10 dayes old, cometh to South at 8 a Clock and 0 min. unto which if you add the time of flowing at Full and Change, the ſum will be time of full Sea at the ſame place. As here at *London*, the time of flowing at Full and Change is at 3 of the Clock, which you are to add to the Moons Southing, and the Sum is 11, which is the time of High-Water when the Moon is 10 dayes old.

To find the Hour of the Night by the Shadow of the Moon upon a Sun-Dial.

First find her coming to South (as before) then see how many hours and minutes the shadow wants of the hour of 12; which hours and minutes take from the hour and minute of the Moons coming to South, and the remainer is the hour of the night; but if the shadow be past the hour of 12, then you must add so many hours and minutes as the shadow is past 12 to the hour and minute of the Moons coming to South, and that will be the hour of the night.

Example.

On the 26 of *November* 1669 I find the Moon to be 13 dayes old, and therefore she comes to South at 10 a Clock and 24 min. past; and suppose the same night you look upon a Sun-Dial, and should find the shadow to be half an hour past 9, which wants 2 hours and a half of the 12 a Clock Line; which 2 hours and half being taken from 10 hours 24 minutes, the time of Moons Southing, the remainer will be seven of the Clock and fifty four Minutes, which is the time of the night desired. Again suppose the same night the shadow of the Moon on the Dial had fallen on the hour of 1, that is one hour past the Line of 12, and therefore an hour must be added to the Moons coming to South, and that is the hour of the Night, which is 11 of the Clock and 24 Minutes.

A Table of the Tydes of the Sea-coasts of Great Britain, Ireland, Norway, Holland, Flanders, France, Biscay, &c. Shewing what Moon makes a Full Sea in each of these places, at every day of the Moons Age, after the Full or Change.

The Description and Use of the Tables.

FIrst you are to understand that the First Column of the Tables sheweth the Age of the Moon after her Full and Change; and the Second and Third Columns shew the Hour and Minute of Full-Sea at each respective place mentioned in the said Table; and the Fourth Collumn sheweth the Names of the said places; and the Fifth sheweth the setting of the Tides upon the same Point of the Compass, expresst in the Title. And also in the Title you have the Hour when the Moon cometh upon each respective point of the Compass at Full and Change. The Use of which Tables shall be further Illustrated by this following

Example.

Suppose you would know what Moon makes a Full-Sea at *Dartmouth* and *Tor-Bay*, and at what Hour it cometh to such a point of the Compass, and the time of High-Water any Day of the Moons Age; First, Look for *Torbay* or *Dartmouth*, which you will find in *Page* 43 of the Tables, under the Title ● *East* and by *North*, and *West* and by *South*, which doth shew that at the Full and Change of the Moon she cometh on that point of the Compass, which is at 5h 15′ in time, when it is Full-Sea in the forementioned places.

So likewise if it be demanded what time it will be Full-Sea when the Moon is six dayes after the Full or Change; Therefore look in the first Column for 6, and right against it in the second and third Collumns you will find 10 of the Clock and 3 Minutes past, which is the time of Full-Sea in the forementioned places, at that Day of the Moons Age.

North

North and South.

D	H	M	12 hour. 0 min.	Setting of the Tydes upon the same point.
0	12	0		
1	12	48	At the Islands of *Jutland*.	
2	1	36	Before the *Hever*, *Eider* and *Elve*.	
3	2	24	At *Emden* and *Delfziel*. Before *Enchuy-*	
4	3	12	*sen*, *Horn* and *Wreck*. On all the Coasts of	
5	4	0	*Flanders*; at the *Northforeland*; at *Dover*	
6	4	48	in the *Peer*; at *Beachy* on the shore; at	From the *Nesse* to *Bolleigne*.
7	5	36	*Hampton* at the Key. Before *Sherborough*	
8	6	24	and the Race of *Blanchey*. At *Orfordnes*.	
9	7	12	In the *Condado*. At *Gibraltar* in the	
10	8	0	Road.	
11	8	48		
12	9	36		
13	10	24		
14	11	12		
15	12	0		

North and by East, and South and by West.

D	H	M	12 hours. 45 min.	Setting of the Tydes upon the same point.
0	12	45		
1	1	33	Within the *Maes*.	
2	2	21	Within *Terveer*.	
3	3	9	At *Flushing*.	
4	3	57	Thwart of *Beach* in the *Offing*.	
5	4	45	In the *Cammer* of *Rye*.	From *Bolleign* to the *Somme*.
6	5	33	At *Winchelsee*.	Also from *Staples* to *Bolleigne*.
7	6	21	In *Garnsey*.	
8	7	9		
9	7	57		
10	8	45		
11	9	33		
12	10	21		
13	11	9		
14	11	57		
15	12	45		

North

North-north-east, and South-south-West.

D	H	M	1 hour. 30 min.	Setting of the Tydes upon the same point.
0	1	30		
1	2	18	Under *Holy Land*. Before the *Maſe* and *Goree*. Before *Terveer*. At *Armuyen*.	
2	3	6		
3	3	54	Upon the *Flat*. The *Weilings*. On the	
4	4	42	Coaſts of *Zeland*.	
5	5	30	Before the River of *Thames*.	From *Calice* to *Bolleigne*.
6	6	18	Before *Yarmouth*.	
7	7	6	In *Downes Road*.	
8	7	54	Thwart of *Dongie Neſſe*.	
9	8	42	At the Weſt end of *Wight*.	
10	9	30	Without *Callice* and *Blackneſs*.	
11	10	18	In *Bluet*.	
12	11	6	At *Bell-Iſle* on the Land.	
13	11	54		
14	12	42		
15	1	30		

Northeaſt and by North, and Southweſt and by South.

D	H	M	2 hour. 15. min.	Setting of the Tydes upon the same point.
0	2	15		
1	3	3	Without *Fountnay*.	
2	3	51	Without *Bluet*.	
3	4	39	Under *Bell-Iſle*.	
4	5	27	Before the *Wielings*.	
5	6	15	Before the *Maeſe*.	
6	7	3		
7	7	51		
8	8	39		
9	9	27		
10	10	15		
11	11	3		
12	11	51		
13	12	39		
14	1	27		
15	2	15		

Between *Calice* and *Dover*. From *Dunkirck* to *Graveling*. From *Staples* to *Fecam*. From *Dartmouth* to *Exmouth*.

North-

North-East. and South-West,

Day	Ho.	Min.
0	3	0
1	3	48
2	4	36
3	5	24
4	6	12
5	7	0
6	7	48
7	8	36
8	9	24
9	10	12
10	11	0
11	11	48
12	12	36
13	1	24
14	2	12
15	3	0

3 hour. 0 min.

At *London*, *Amsterdam*, *Rotterdam*, *Dort*, and *Zierickzee*. Before *Newcastle*. In *Robinhoods-Bay*. Before the *Tees* and *Hartlepole*. Without the *Flemish Banks*. In the Strait between *Callide* and *Dover*. Before *Conquet*. The *Pouns*, *Groy*, *Armentiers*, *Use*, *Killiars*, *Porthou*, the River of *Burdeaux*, the South Coast of *Bretaigne*, *Gascoigne* and *Poictou*. The Coasts *Biscay*, *Gallicia*, *Portugal* and of *Spain*.

On the West Coast of *Ireland*.
At *Boecknes* and *Orcanies*.
In *Hitland* and *Fayrehil*.

Setting of the Tydes upon the same point.

From *C. de Hague* to *Alderney*, through the Race of *Alderney*.
From *Garnzey* to the *Caskets*.
From *Milford* to *Ramsey*.

North-East and by East, and South-West and by West.

Day	Ho.	Min.
0	3	45
1	4	33
2	5	21
3	6	9
4	6	57
5	7	45
6	8	33
7	9	[illegible]1
8	10	9
9	10	57
10	11	45
11	12	33
12	1	21
13	2	9
14	2	57
15	3	45

3. hour. 45. m.

Between the *Heads* and the *Mase*.
At *Roan*. In *Silly*. Before S. *Matthews point*. In *Brest* and *Croydon*.
In the *Sound* between *Ushant* and the *Mayn*.
Before the *Basse*.
At S. *Martens*. Before *Rochel*.
Before *Brouage*, at *Rouan* in the *River* of *Bordeaux*. Within the Havens on the coasts of *Spain*, *Portugal*, *Gallicia*, the South side of *Bretaigne*, *Gascoine*, and the West-Coast of *Ireland*.

Setting of the Tydes upon the same point.

From *Struysart* to *Deep*.
From the *Lizart* to the *Start*.
From *Cape Cleer* unto *Londey*.

East-

East-north-east, and VVest-south-west.

D	H	M
0	4	30
1	5	18
2	6	6
3	6	54
4	7	42
5	8	30
6	9	18
7	10	6
8	10	54
9	11	42
10	12	30
11	1	18
12	2	6
13	2	54
14	3	42
15	4	30

4 hour. 30 min.

From the *Texel* to the Heads in the *Fairway*.
Before the *Hommer*.
Before *Flambrough* and *Scarbrough*.
Abberwark. In *Falmouth*. In *Mouſehole*. *Set Iſles*. S. *Pauls* without the Haven. Between *Garnſey* and *Set Iſles* in the *Fairway*. In the *Broad-Sound*. Without the *Fourne*. All the South Coaſt of *Ireland*, as *Kingſale*, *Cork*, *Yochal*, *Waterford* and *Cape Cleere*.

Setting of the Tydes upon the ſame point.

From *Oſtend* to S. *Kath*. Fr. *Barchſleur* to *Struyſart*. The *Br. Sound* out and in. From *C. Cleer* to the Iſle *Saltees*. Between *Londey* & the *Holmes* unto *Briſtol*. From *Silly* to Lands End of *Engl*. From *the Start* to *Portland*.

East and by North, and VVest and by South.

D	H	M
0	5	15
1	6	3
2	6	51
3	7	39
4	8	27
5	9	15
6	10	3
7	10	51
8	11	39
9	12	27
10	1	15
11	2	3
12	2	51
13	3	39
14	4	27
15	5	15

5 hour. 15 min.

In *Torbay* and *Dartmouth*.
In *Plymmouth* and *Foy*.
In the Sea of *Wales*.
In *Falmouth* and *Milford*.
At *Ramſey* in *Wales*.
Thwart of *Londey*.
Before *Lin* in *England*.
In all the Havens upon the South Coaſt of *Ireland*.

Setting of the Tydes upon the ſame point.

From the Iſle of *Baſt* to the *Fourn*
From the *Dorſeys* to *Cape Cleere*.
From *Silly* to the *Lizard*.
From *Portl.* to *Wight*.
From *Wight* to *Beachy*.

East and West.

D	H	M	6 hour. 0 min.	*Setting of the Tydes upon the same point.*
0	6	0		
1	6	48	Before *Hamburg.*	
2	7	36	Before *Bremen.*	
3	8	24	Before *Marsdeep* or *Tessel.*	
4	9	12		
5	10	0	At *Hull.*	
6	10	48	At *Blakeney* and *Wels.*	
7	11	36	Before *Anwerp.*	
8	12	24	*Ter Goes.*	
9	1	12	At *Concalla* and S. *Mallows.*	
10	2	0	S. *Powles* in the Haven.	
11	2	48	Without *Scilly* in the Channel.	
12	3	36		
13	4	24		
14	5	12		
15	6	0		

From the *Casquets* to *Berchsleur.* From the Lands end of *England* to the *Lizard.*

East and by South, and West and by North.

D	H	M	6 hour. 45 min.	*Setting of the Tydes upon the same point.*
0	6	45		
1	7	33	Between *Foy* and *Falmouth* in the Chan-	
2	8	21	nel.	
3	9	9	At *Bristol* at the Key.	
4	9	57	Before S. *Nicholas* and *Podessemske.*	
5	10	45	At *Waymouth* at the Key.	
6	11	33		
7	12	21		
8	1	9		
9	1	57		
10	2	45		
11	3	33		
12	4	21		
13	5	9		
14	5	57		
15	6	45		

From the Isle *de Bass* to *Marwaen* alongst the Land.

East-

East-south-east, and West-north-west.

D	H	M	7 hour. 30 min.	*Setting of the Tydes upon the same point.*
0	7	30		
1	8	18	At the *Ness* by *Wieringhen.*	
2	9	6	In the Road of *Texel.*	
3	9	54	At *Kilduyn.*	
4	10	42	Amidst the Channel in the *Fareway.*	
5	11	30	Thwart of the *Start* in the Channel.	
6	12	18	Between *Mousehole* and *Falmouth* in the *Offing.*	From the Island *Bryack* to St. *Malloes.*
7	1	6	Thwart of *Plimmouth* in the *Offing.*	
8	1	54	At the *Lizard* on the Land.	From *Berchfleur* unto *Seynhead.*
9	2	42		
10	3	30		
11	4	18		
12	5	6		
13	5	54		
14	6	42		
15	7	30		

South-east and by East, and North-west and by West.

D	H	M	8 hour. 15 min.	*Setting of the Tydes upon the same point.*
0	8	15		
1	9	3	Without the *Casket* in the Channel	
2	9	51	Thwart of *Wight* in the Channel.	
3	10	39	From *Wight* to *Beachy* by the Land.	
4	11	27	On the Coast by west the *Foreland.*	
5	12	15	Without the *Fly.*	Behind *Garnsey* in the *Fairway.*
6	1	3		Without the *Seven Islands.*
7	1	51		
8	2	39		
9	3	27		
10	4	15		
11	5	3		
12	5	51		
13	6	39		
14	7	27		
15	8	15		

South-east, and North-west.

D	H	M	9 hour. 0 min.	Setting of the Tydes upon the same point.
0	9	0		
1	9	48	Before the Easter and Wester *Weemses.*	
2	10	36	Before the *Fly.* Before the *Scholbalgh.*	
3	11	24	On all the Coasts of *Friesland.* Upon the *Frize* and *Wieringer Flat.*	
4	12	12	Before *Cormer, Winterton,* and *Yarmouth.*	In the Bay *Benviit.*
5	1	0	Within the *Seyne.*	Between *Morliax* and the *Triacle Potts.*
6	1	48	At the east end of *Wight.*	
7	2	36	In the Race of *Portland.*	
8	3	24	Between *Garnsey* and the *Casketts.*	
9	4	12		
10	5	0		
11	5	48		
12	6	36		
13	7	24		
14	8	12		
15	9	0		

South-East and by South, and North-West and by North.

D	H	M	9 hours. 45 min.	Setting of the Tydes upon the same point.
0	9	45		
1	10	33	The *Needls* of *Wight.*	
2	11	21	In the Channel thwart of *Wight.*	
3	12	9	The *Caskets.*	
4	12	57	Thwart of *Garnsey* in the Channel.	
5	1	45	Thwart of *Leystaffe* and *Yarmouth* without the Banks.	Before *Concalo.*
6	2	33		
7	3	21	*Ter Gou.*	Before the Island of S. *Michael* in the Bay.
8	4	9	At *Dunnose* of *Wight:*	
9	4	57		
10	5	45		
11	6	33		
12	7	21		
13	8	9		
14	8	57		
15	9	45		

South

South-south-east, and North-north-west.

Day	Ho.	Min.	10 hour. 30 min.	Setting of the Tydes upon the same point.
0	10	30		
1	11	18	At *Orfordneſs* and *Harwich* without the Banks.	
2	12	6		
3	12	54	At *Leyſtaf* in the Road. *Yarmouth* in the Road. Before the River of *Thames*.	
4	1	42		From *Berchfleur* to *Alhonga*. From C. *Dorſey* to the Iſland *Dardan*.
5	2	30	At *Wight* within.	
6	3	18	At *Bolloign*, *Deep*, and *Seymehead*.	
7	4	6	In the *Foſſe* of *Caen*.	
8	4	54	At *Struyſart* and all the Coaſt of *Normandy* and *Picardy*.	
9	5	42		
10	6	30	At S. *Ellens* and the *Conet*.	
11	7	18		
12	8	6		
13	8	54		
14	9	42		
15	10	30		

South and by East, and North and by West.

Day	Ho.	Min.	11. hour. 15. m.	Setting of the Tydes upon the same point.
0	11	15		
1	12	3	Between *Cripple Sand* and the *Creyl*.	
2	12	51	At *Orfordneſs* within.	
3	1	39	At *Hampton*. At *Portſmouth*, and at *Dunnoſe*.	
4	2	27		
5	3	15	At the *Cows* in *Wight*.	
6	4	3	Before the Haven of *Caen*.	
7	4	51		From St. *Matthews Point* to the *Bake-Ovens*. From *Fontnay* to St. *Matthews Point*.
8	5	39		
9	6	27		
10	7	15		
11	8	3		
12	8	51		
13	9	39		
14	10	27		
15	11	15		

1668.

Mo.	Moons Age	D	H	M
January.	New moon.	3	7	33
	First quart.	10	11	46
	Full moon.	18	16	20
	Last quart.	26	1	38
February.	New moon.	1	19	9
	First quart.	9	18	9
	Full moon.	17	8	15
	Last quart.	24	9	25
March.	New moon.	2	7	37
	First quart.	10	4	33
	Full moon.	17	21	13
	Last quart.	24	16	11
	New moon.	31	21	5
April.	First quart.	8	23	32
	Full moon.	16	7	21
	Last quart.	22	22	47
	New moon.	30	11	31
May.	First quart.	8	5	29
	Full moon.	15	15	30
	Last quart.	22	6	23
	New moon.	30	2	30
June.	First quart.	7	4	11
	Full moon.	13	22	30
	Last quart.	20	16	16
	New moon.	28	20	32
July.	First quart.	6	14	2
	Full moon	13	5	22
	Last quart.	20	4	43
	New moon	28	8	37
August.	First quart.	4	21	49
	Full moon	11	13	0
	Last quart.	18	20	21
	New moon	26	22	56
September.	First quart.	3	4	26
	Full moon	9	23	1
	Last quart.	17	14	40
	New moon	25	12	15
October.	First quart.	2	10	45
	Full moon	9	11	30
	Last quart.	17	11	1
	New moon	25	0	48
	First quart.	31	18	27
November.	Full moon	8	2	49
	Last quart.	16	7	11
	New moon	23	12	26
	First quart.	30	4	3
December.	Full moon	7	20	54
	Last quart.	16	1	33
	New moon	22	23	16
	First quart.	29	16	18

There will be 4 Eclipses this Year. Two of the Sun, and two of the Moon. The first Eclipse of the Sun will be the 30th of *April* near our midnight, but not conspicuous to any part of *Europe*. The second will be the 25th of *October* in the afternoon, and to be seen in *England*.

The first Eclipse of the Moon will be on the 16th of *May* in the morn. The 2d. is a partile Eclipse of the Moon *Nov.* 8. aftern. visible in the east part of the world.

Month

1669.

Mo.	Moons Age	D	H	M	Mo.	Moons Age	D	H	M
January.	Full moon	6	16	35	July.	Full moon	2	22	38
	Last quart.	14	16	44		Last quart.	9	13	40
	New moon	21	9	43		New moon	17	9	27
	First quart.	28	7	19		First quart.	15	11	21
February.	Full moon	5	11	38	August.	Full moon	1	5	42
	Last quart.	13	4	21		Last quart.	7	23	36
	New moon	19	19	55		New moon	16	1	35
	First quart.	27	0	41		First quart.	23	22	54
						Full moon	30	15	13
March.	Full moon	7	4	36	September.	Last quart.	6	13	19
	Last quart.	14	12	52		New moon	14	17	29
	New moon	21	6	22		First quart.	22	6	52
	First quart.	28	19	30		Full moon.	28	22	39
April.	Full moon	5	18	50	October.	Last quart.	6	6	30
	Last quart.	12	19	15		New moon	14	9	22
	New moon	19	17	22		First quart.	21	14	50
	First quart.	27	14	4		Full moon.	28	10	5
May.	Full moon	5	5	58	November.	Last quart.	5	2	53
	Last quart.	12	0	33		New moon	13	0	16
	New moon	19	5	27		First quart.	16	22	8
	First quart.	27	7	31		Full moon	27	0	7
June.	Full moon	3	15	6	December.	Last quart.	5	1	0
	Last quart.	10	6	22		New moon.	12	13	41
	New moon	17	6	21		First quart.	19	7	9
	First quart.	25	22	37		Full moon.	26	16	43

There will be two Solar Eclipses this Year. The first on the 21th of *April*, by 5 in the morning, which will appear terrible to those in the *East-Indies*, near the *Æquinoctial*.

The other will be on the 14 of *October*, at 9 hours 24 minutes; Visible to those parts beyond the *Æquinoctial* Circle.

Month

1670.

Mo.	Moons Age	D	H	M	Mo.	Moons Age	D	H	M
January.	Last quart.	3	21	25	July.	New moon	6	12	31
	New moon	11	1	36		First quart.	14	14	23
	First quart.	17	17	11		Full moon	21	22	16
	Full moon.	25	8	45		Last quart.	28	13	39
Febrnary.	Last quart.	2	15	0	August.	New moon	5	2	6
	New moon	9	11	56		First quart.	13	6	4
	First quart.	16	5	3		Full moon	20	6	15
	Full moon	29	5	41		Last quart.	26	21	43
March.	Last quart.	4	5	2	September.	New moon	3	17	52
	New moon	10	21	18		First quart.	11	20	2
	First quart.	17	19	3		Full moon	18	14	36
	Full moon	25	23	8		Last quart.	25	9	0
April.	Last quart.	2	14	51	October.	New moon	3	11	12
	New moon	9	6	7		First quart.	11	7	56
	First quart.	16	10	56		Full moon	17	23	47
	Full moon	24	14	13		Last quart.	25	0.	14
May.	Last quart.	1	21	53	November.	New moon	2	5	7
	New moon	8	15	6		First quart.	9	18	10
	First quart.	16	4	3		Full moon	16	10	33
	Full moon	24	2	57		Last quart.	23	19	28
	Last quart.	31	3	1					
June.	New moon	7	0	5	December.	New moon	1	22	21
	First quart.	14	21	32		First quart.	9	3	11
	Full moon	22	13	21		Full moon	15	23	8
	Last quart.	29	7	54		Last quart.	23	17	20
						New moon	31	13	44

There will be 4 Eclipſes this Year. Two of the Sun, and two of the Moon. The firſt is a partile Eclipſe of the Moon, *March* 25, about 11 of the Clock before Noon. The ſecond is a partile Eclipſe of the Sun upon the 9th of *April*, not ſeen of us. The third is a partile Eccliple of the Moon, *September* 18. viſible at *London*. The 4th. is of the Sun, upon the 3d. of *October*, not ſeen of us.

Month

1671.

Mo.	Moons Age	D	H	M	Mo.	Moons Age	D	H	M
January.	First quart.	7	11	25	July.	First quart.	3	11	5
	Full moon.	14	13	51		Full moon	11	10	0
	Last quart.	22	14	58		Last quart.	18	10	14
	New moon	30	2	51		New moon	25	8	11
February.	First quart.	5	19	43	August.	First quart.	2	4	42
	Full moon	13	6	5		Full moon	9	20	51
	Last quart.	21	10	32		Last quart.	16	15	30
	New moon	28	13	42		New moon	23	20	18
						Frist quart.	30	15	35
March.	First quart.	7	4	58	September.	Full moon	8	6	36
	Full moon	14	23	8		Last quart.	14	22	15
	Last quart.	23	2	30		New moon	22	11	23
	New moon	29	22	38		First quart.	30	15	35
April.	First quart.	5	15	39	October.	Full moon	07	16	10
	Full moon	13	16	3		Last quart.	14	7	49
	Last quart.	21	14	29		New moon	22	4	57
	New moon	28	6	27		First quart.	30	7	14
May.	First quart.	5	4	4	November.	Full moon	6	2	4
	Full moon	13	7	47		Last quart.	12	21	0
	Last quart.	20	23	2		New moon	21	0	1
	New moon	27	14	2		First quart.	20	20	20
June.	First quart.	3	18	32	December.	Full moon	5	12	20
	Full moon	11	21	49		Last quart.	12	13	56
	Last quart.	19	5	14		New moon	20	18	54
	New moon	25	22	18		First quart.	28	7	0

This Year there will be but 2 remarkable Eclipses (although there may be two more, yet inconsiderable.)

The first is on the 15 of *March*, near 11 of the Clock at night, not visible to us.

The other *September* the 8th. the latter end only seen by us.

1672.

Mo.	Moons Age	D	H	M	Mo.	Moons Age	D	H	M
January.	Full moon.	4	0	11	July.	Last quart.	7	7	44
	Last quart.	11	10	44		New moon.	13	21	36
	New moon.	19	00	48		First quart.	21	3	8
	First quart.	26	17	19		Full moon	29	5	17
February.	Full moon.	2	0	51	August.	Last quart.	5	13	56
	Last quart.	10	11	35		New moon	12	6	13
	New moon.	18	3	8		First quart.	19	21	4
	First quart.	23	49	0		Full moon	27	18	24
March.	Full moon.	3	2	47	September.	Last quart.	3	18	45
	Last quart.	11	3	10		New moon.	10	17	16
	New moon.	18	14	48		First quart.	18	14	28
	First quart.	25	6	21		Full moon	26	4	50
April.	Full moon.	1	17	53	October.	Last quart.	3	0	22
	Last quart.	9	3	10		New moon	10	7	10
	New moon.	17	0	0		First quart.	18	9	41
	First quart.	23	14	7		Full moon	25	18	5
May.	Full moon.	1	9	15	November.	Last quart.	1	8	36
	Last quart.	9	11	32		New moon	9	0	5
	New moon.	16	7	24		First quart.	17	4	23
	First quart.	23	0	4		Full moon	23	4	49
June.	Full moon.	31	0	28	December.	Last quart.	30	20	13
	Last quart.	7	23	12		New moon	8	19	1
	New moon.	14	14	26		First quart.	16	21	14
	First quart.	21	12	21		Full moon	23	15	14
	Full moon	30	15	16		Last quart.	30	11	19

There will be 4 Eclipses this Year. Two of the Sun, and two of the Moon. The first Eclipse of the Sun will be the 18th of *February*. The second of the Moon the 3d. of *March*. The third of the Sun the 12th. of *August*. The 4th. of the Moon the 27th. of *August*. None to be seen of us but the last of the Sun.

Month

1673.

Mo.	Moons Age	D.	H	M	Mo.	Moons Age	D	H	M
January.	New moon	27	14	36	July.	New moon	3	14	41
	First quart.	15	11	10		First quart.	10	7	10
	Full moon	22	1	40		Full moon	18	7	29
	Last quart.	29	6	0		Last quart.	26	6	22
February.	New moon	6	9	0	August.	New moon	1	21	4
	First quart.	13	29	30		First quart.	8	19	56
	Full moon	20	12	36		Full moon	16	22	53
	Last quart.	27	23	41		Last quart.	24	15	35
						New moon	31	5	49
March.	New moon	8	0	48	September.	First quart.	7	11	52
	First quart.	15	4	33		Full moon.	15	14	14
	Full moon	22	0	10		Last quart.	22	22	56
	Last quart.	29	18	44		New moon	29	15	47
April.	New moon	6	13	46	October.	First quart.	7	6	23
	First quart.	13	9	46		Full moon.	15	4	57
	Full moon	20	12	44		Last quart.	22	3	13
	Last quart.	28	12	44		New moon	29	4	28
May.	New moon	5	23	43	November.	First quart.	6	2	31
	First quart.	12	14	44		Full moon	13	18	52
	Full moon	20	1	4		Last quart.	20	12	19
	Last quart.	28	4	28		New moon	27	20	9
June.	New moon	4	7	42	December.	First quart.	5	21	8
	First quart.	10	21	34		Full moon.	13	6	51
	Full moon	18	16	29		Last quart.	19	21	31
	Last quart.	26	18	52		New moon.	27	14	12

There will be two Solar Eclipses this Year. The first on the 6th of *Febrnary*.

The other will be on the 2d. of *Auguſt* about 9 of the clock in the morning, and to be ſeen a little in *Spain*, but much in *Africa*.

1674.

Mo.	Moons Age	D	H	M	Mo.	Moons Age	D	H	M
January.	First quart.	4	18	16	July.	Full moon	7	9	5
	Full moon	11	17	50		Last quart.	15	12	6
	Last quart.	18	9	41		New moon	21	14	54
	New moon	26	9	14		First quart.	28	4	43
February.	First quart.	3	10	23	August.	Full moon	5	23	44
	Full moon	10	3	47		Last quart.	14	2	30
	Last quart.	17	0	16		New moon	20	22	30
	New moon	25	3	47		First quart.	27	15	19
March.	First quart.	4	23	14	September.	Full moon.	4	15	45
	Full moon	11	13	17		Last quart.	12	14	57
	Last quart.	18	16	44		New moon	19	6	37
	New moon	26	20	26		First quart.	26	5	32
April.	First quart.	3	7	51	October.	Full moon.	4	9	4
	Full moon	9	22	50		Last quart.	12	1	41
	Last quart.	17	9	56		New moon	18	16	12
	New moon	25	10	24		First quart.	24	23	12
May.	First quart.	2	13	18	November.	Full moon	3	1	55
	Full moon	9	8	54		Last quart.	10	10	17
	Last quart.	17	3	24		New moon	17	3	39
	New moon	23	21	44		First quart.	24	19	39
	First quart.	30	17	13					
June.	Full moon	8	20	14	December.	Full moon.	2	17	50
	Last quart.	15	20	19		Last quart.	9	17	46
	New moon	23	6	56		New moon.	16	17	46
	First quart.	29	21	41		First quart.	23	16	29

There will be 5 Eclipses this Year. Three of the ☉ and two of the ☽. The first of the ☽ *January* 12, seen by us. The 2d. of ☉ *Jan.* 26 to the *North-East*. The 3d. of the ☽ *July* 7, seen by us. The 4th of the ☉ *July* 23, to the *South-East*. The 5th of the ☉ the 17th of *December*, seen toward the *South Pole*.

Month

1675.

Mo.	Moons Age	D	H	M
January.	Full moon.	1	7	54
	Last quart.	8	1	17
	New moon.	15	10	3
	First quart.	23	13	0
	Full moon.	30	19	53
February.	Last quart.	6	10	30
	New moon.	14	3	36
	First quart.	22	7	10
	Full moon.	1	5	49
March.	Last quart.	7	21	22
	New moon.	15	21	22
	First quart.	23	21	56
	Full moon.	30	14	26
April.	Last quart.	6	11	1
	New moon.	14	14	0
	First quart.	21	8	45
	Full moon.	28	22	30
May.	Last quart.	6	1	48
	New moon.	14	4	57
	First quart.	21	15	53
	Full moon.	28	6	50
June.	Last quart.	4	17	53
	New moon.	12	17	48
	First quart.	19	20	20
	Full moon	27	16	6
July.	Last quart.	4	10	45
	New moon	12	4	48
	First quart.	19	0	0
	Full moon	26	3	22
August.	Last quart.	3	3	49
	New moon	10	14	26
	First quart.	17	15	11
	Full moon	24	16	58
September.	Last quart.	1	20	29
	New moon	8	23	26
	First quart.	15	13	3
	Full moon	23	9	2
October.	Last quart.	1	12	11
	New moon	8	8	19
	First quart.	15	1	43
	Full moon	22	2	56
	Last quart.	30	2	19
November.	New moon	6	17	56
	First quart.	13	17	38
	Full moon	21	21	42
	Last quart.	29	14	0
December.	New moon	6	4	42
	First quart.	13	12	45
	Full moon	21	15	36
	Last quart.	28	23	17

There will be 4 Eclipses this Year. Two of the Sun, and two of the Moon. The first Eclipse of the Moon the *Jan.* 1. The second of the Sun the 13th of *June*. The third of the Moon the 27th. of the same. All seen by us. The 4th of the Sun the 6th of *December* toward the South.

CHAP.

CHAP. IV.

Shewing the Nature of the three Hypotheſis or Syſtems of the Viſible World;

Viz. the { Ptolomaick, Tychonean and Copernican.

Alſo a Table of the Right Aſcenſion of ſome Notable Fixed Stars.

Firſt of the Ptolomaick, *by* Ptolomy.

THE *Ptolomaick Syſtems* is that which was firſt Invented; and ſuppoſeth the Earth to be fixed in the Center, and that all the Celeſtial Bodies do move round the ſame in their Diurnal and Annual Revolutions: which are ſuppoſed to be divided principally into two parts, Elemental, and Celeſtial.

The Elementary admitts of four Diviſions,

The firſt is of the *Earth*.

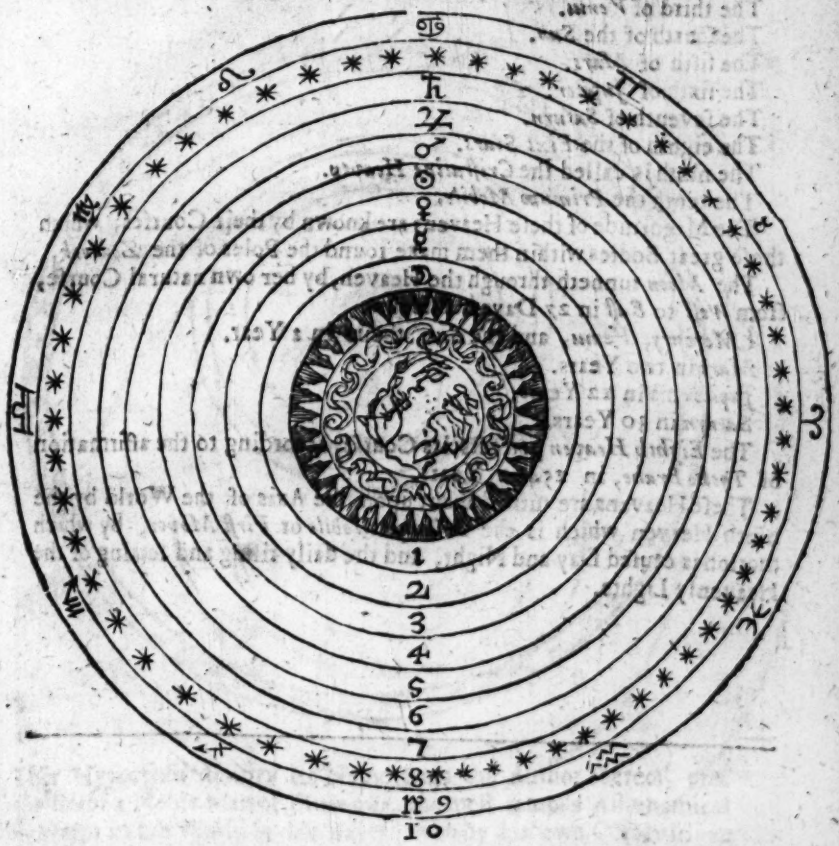
The ſecond is the *Water*; both which make one entire Body or Globe, whereon we dwell.

The third is the *Air*, encompaſſing the *Earth*.

And the fourth is the *Fire*, which according to the Opinion of Philoſophers is contained in that ſpace between the *Air* and the Sphere of the *Moon*; As you may ſee in the following Figure.

The

The Figure of the Ptolomaick Systeme.



These four Elements are subject to a continual Change and Alteration one into another; according to the Proverb,

Omnia sub Lunari Mutabilia,

The Celestial part is that which is without these Elementary parts, and

and is void of all Changes; and is by the antient Astronomers divided into 10 Parts or Heavens.

The first of which next the Region of the *Fire*, is the Heaven or Orbe of the *Moon*.

The second of *Mercury*.

The third of *Venus*.

The fourth of the *Sun*.

The fifth of *Mars*.

The sixth of *Jupiter*.

The seventh of *Saturn*.

The eighth of the *Fixt Stars*.

The ninth is called the *Cristaline Heaven*.

The tenth the *Primum Mobile*.

The Magnitude of these Heavens are known by their Courses, which those great Bodies within them make round the Poles of the *Zodiack*.

The *Moon* runneth through the Heaven, by her own natural Course, from *West* to *East* in 27 Dayes, 8 Hours.

Mercury, *Venus*, and the *Sun*, theirs in a Year.

Mars in two Years.

Jupiter his in 12 Years.

Saturn in 30 Years.

The *Eighth Heaven* perfects its Course, according to the affirmation of *Tycho Brahe*, in 25400 Years.

These Heavens are turned about upon the Axis of the World by the ninth Heaven which is the *Primum Mobile* or *First Mover*, by which motion is caused Day and Night, and the daily rising and setting of the Heavenly Lights.

The

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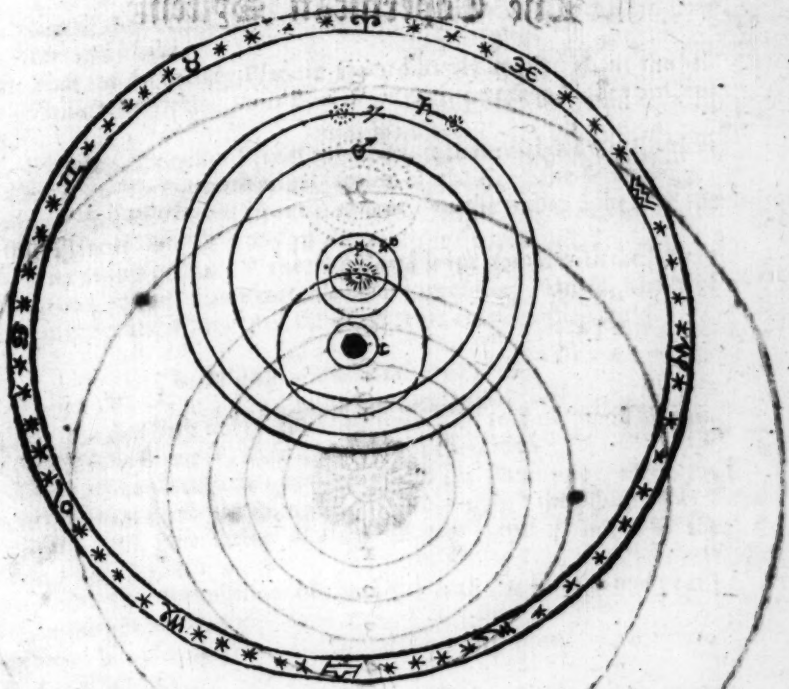
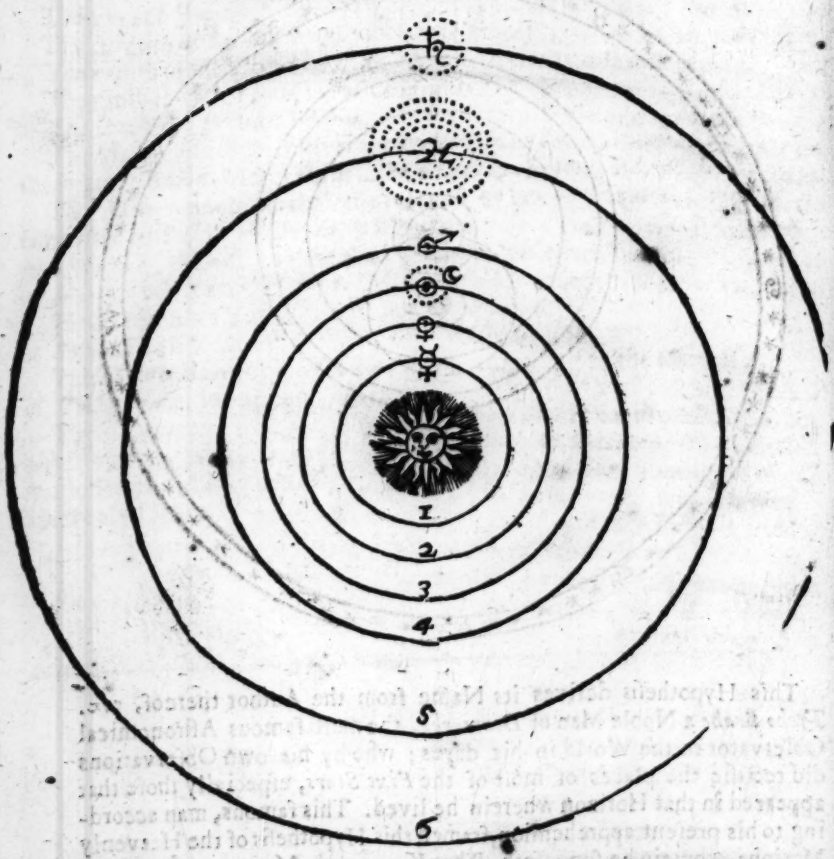
The Tychonean Systeme.



This Hypotheſis derives its Name from the Author thereof, *viz.* *Tycho Brahe* a Noble Man of *Denmarke*, the moſt famous Aſtronomical Obſervator in the World in his dayes; who by his own Obſervations did rectifie the places of moſt of the *Fixt Stars*, eſpecially thoſe that appeared in that Horizon wherein he lived. This famous man according to his preſent apprehenſion, framed this Hypotheſis of the Heavenly Motions, wherein he ſuppoſeth, That *Venus* and *Mercury* move about the Sun, and that all the other Planets (except the *Moon*) reſpect the *Sun* for their Center; and that *Saturn* in Oppoſition to the *Sun* is nearer to

the Earth than *Venus* in *Apogeon*; and that *Mars* in Oppoſition is nearer the Earth, than the *Sun* it ſelf: as may appear in the ſaid Hypotheſis.

The Copernican Syſtem



This Hypotheſis was firſt invented and framed by *Copernicus*, a famous Aſtronomer of *Germany*, who lived in the Year 1500, and ſuppoſed, 1. That

1. That the Sun is placed in the middle of the World, in or about the Center of the Sphere of the fixed Stars, and hath no circular motion but central only.

2. The primary Planets are each of them in their proper Syſtems moved about the Sun, and accompliſh their Periodical Revolutions moſt exactly in their determinate and appointed times.

3. That the Earth is one of the Plannets, and with her annual motion about the *Sun* deſcribeth her Orb in the middle between the Orbs of *Mars* and *Venus*.

4. That the ſecondary Planets are ordinarily moved about the primary Planets, reſpecting their Bodies for their common Nodes or Centers.

5. That the ſecondary Planet the *Moon*, is moved about the *Earth* as her Center, where by the annual motion of the *Earth* ſhe hath not only relation to the *Earth*, but by conſequence to the whole Sphere of the earthly Planets.

6. That as this primary Planet the *Earth* is invironed with the Sphere of the *Moon*, ſo are ſome if not all the other primary Planets, who have in like manner their Moons or Concomitants encompaſſing them.

The Motion of the Planitary Syſteme.

Firſt, the *Sun* hath only a Rotation from *Weſt* to *Eaſt*, upon his proper Axis, in the ſpace of twenty ſix dayes or thereabouts.

Secondly, The Planet *Mercury* performs his Revolution about the *Sun* in 88 dayes; which is noted in the Scheme with the figure 1 ☿.

Thirdly, The Revolution of *Venus* in 225 dayes; noted in the Scheme by the figue 2 ♀.

Fourthly, The Revolution of the *Earth* with the *Moon* in one year; noted in the Scheme by the Circle 3.

Fifthly, The Revolution of *Mars* in two years, noted by the figure 4 ♂ in the Scheme.

Sixthly, The Revolution of *Jupiter*, with his 4 Companions, in 12 years, noted with the figure 5 ♃.

Seventhly, The Revolution of *Saturn*, with his Ring, and Moon in 30 years; noted in the Scheme by the Figure 6 ♄.

The ☾ circumvolveth the Earth every moneth; *Jupiters* 4 Attendants him in time correſponding their diſtances from him.

The firſt and next him, in one day 18 hours.

The ſecond next without that, in 3 dayes 13 hours.

The third in 7 dayes 4 hours.

And the fourth and outmost in 16 dayes 8 hours.

Saturn's Moon mooves about him in 16 dayes, and all from *West* to *East* according to their Revolutions about the *Sun*.

Saturn, *Jupiter*, *Mars*, the *Earth*, *Venus* and *Mercury* (whose Revolutions respect the *Sun* only) are called *Primary Planets*.

The rest (that move again) about *Saturn*, *Jupiter* and the *Earth*, *Secondary*.

The *Earth* hath her Revolution upon her *Equinoctial Pole*, in 24 hours, from *West* to *East*.

The *Secondary Planets* are all of them much less in Magnitude than their *Primary*, and all the Planets together much less than the *Sun*, from whom they all receive their Light, Vertue and principal Power of Motion.

Far without the *Planetary Systeme* are placed all the *Fixed Stars*, in several distances, but all unto us incommensurable. The *Paralax* of the *Earths Orb* being insensible in any of their Places.

A Table

A Table of the right Ascentions and Declinations of some of the principal Fixed Stars, for some Years to come.

	Right Ascen.	Declination.	N. or S.	Magni.
	H. M.	D. M.		
Pole Star.	00 : 31	87 : 34	N	2
Andromeda's Girdle.	00 : 50	33 : 50	N	2
Whales Belly.	01 : 35	12 : 00	S	3
Rams Head.	01 : 48	21 : 49	N	3
Whales Mouth.	02 : 44	02 : 42	N	2
Medusa's Head.	02 : 46	39 : 35	N	3
Perseus Right Side.	02 : 59	48 : 33	N	2
Bulls Eye.	04 : 16	15 : 46	N	1
Goat.	04 : 52	45 : 37	N	1
Orions left Foot.	04 : 58	8 : 38	S	1
Orions left Shoulder.	05 : 6	5 : 59	N	3
First in Orions Girdle.	05 : 15	00 : 35	S	3
Second in Orions Girdle.	05 : 19	1 : 27	S	3
Third in Orions Girdle.	05 : 23	2 : 9	S	3
Orions right Soulder.	05 : 36	7 : 18	N	2
The Wagoner.	05 : 39	44 : 56	N	2
Bright foot of the twins.	06 : 18	16 : 39	N	3
Great Dog.	06 : 30	16 : 13	S	1
Castor or Apollo.	07 : 12	32 : 30	N	2
The little Dog.	07 : 22	6 : 6	N	2
Pollux or Hercules.	07 : 24	28 : 28	N	2
Hidra's Heart.	09 : 10	07 : 10	S	1
Lions Heart.	09 : 50	13 : 39	N	1
Lions Neck.	09 : 50	21 : 41	N	3
Great Bears Rump.	10 : 40	58 : 43	N	2
Lions Back.	11 : 30	22 : 4	N	2
Lions Tail.	11 : 31	16 : 30	N	1

A Table of the right Ascensions and Declinations of some of the principal Fixed Stars, for some Years to come.

	Right Ascen.	Declination.	N. or S.	Magni.
	H. M.	D. M.		
The Virgins Girdle.	12 . 38	5 . 20	N	3
First in the great Bears Tail next the Rump.	12 . 38	57 . 51	N	2
Vindemiatrix.	12 . 44	15 . 51	N	3
Virgins spike.	13 . 7	9 . 19	S	1
Middlemost in the great Bears Tail.	13 . 10	56 . 45	N	2
Last in the end of the great Bears Tail.	13 . 34	51 . 05	N	2
Arcturus.	14 . 00	21 . 03	N	1
South Ballance.	14 . 32	14 . 33	S	2
Brightest in the Crown.	15 . 24	27 . 43	N	3
North Ballance.	14 . 58	08 . 03	S	3
Serpentarius left Hand.	15 . 56	02 . 46	S	3
Scorpions Heart.	16 . 08	25 . 35	S	1
Serpentarius left Knee.	16 . 18	09 . 46	S	3
Serpentarius right Knee.	16 . 49	15 . 12	S	3
Hercules Head.	16 . 59	14 . 51	N	3
Serpentarius Head.	17 . 19	12 . 52	N	3
Dragons Head.	17 . 48	51 . 36	N	3
Brightest in the Harp.	18 . 25	38 . 30	N	1
Eagle or Vultures Heart.	19 . 34	08 . 00	N	2
Upper horn of Capricorn.	19 . 58	13 . 32	S	3
Swans Tail.	20 . 30	44 . 05	N	2
Left shoulder of Aquarius.	21 . 13	07 . 02	S	3
Pegasus Mouth.	21 . 27	08 . 19	N	3
Right shoulder of Aquarius.	21 . 48	11 . 58	S	3
Foma Hant.	22 . 39	31 . 17	S	3
Pegasus upper Wing, or Marchab.	22 . 48	13 . 21	N	2
Pegasus lower Wing.	23 . 55	33 . 25	N	2

Dayes.	January		February		March		April		May		June	
	Suns right aſcen.		Suns right aſcen.		Suns right aſcen.		Suns right aſcen.		Suns right aſcen.		Suns right aſcen.	
	H	M	H	M	H	M	H	M	H	M	H	M
1	19	35	21	42	23	28	1	21	3	14	5	19
2	19	39	[illegible]	46	23	32	1	25	3	18	5	23
3	19	43	21	50	23	36	1	29	3	22	5	27
4	19	47	21	54	23	39	1	33	3	26	5	31
5	19	51	21	58	23	43	1	36	3	30	5	36
6	19	56	22	02	23	46	1	40	3	34	5	40
7	20	00	22	06	23	50	1	44	3	38	5	44
8	20	04	22	10	23	53	1	47	3	42	5	48
9	20	09	22	14	23	57	1	51	3	46	5	52
10	20	13	22	17	0	01	1	54	3	50	5	56
11	20	17	22	21	0	05	1	58	3	54	6	00
12	20	22	22	25	0	08	2	02	3	58	6	04
13	20	26	22	29	0	12	2	06	4	02	6	08
14	20	30	22	33	0	15	2	10	4	06	6	12
15	20	34	22	36	0	19	2	13	4	10	6	17
16	20	38	22	40	0	23	2	17	4	14	6	21
17	20	42	22	44	0	26	2	21	4	18	6	25
18	20	46	22	48	0	30	2	15	4	22	6	29
19	20	50	22	52	0	33	2	29	4	26	6	33
20	20	54	22	55	0	37	2	32	4	30	6	38
21	20	58	22	59	0	41	2	36	4	34	6	42
22	21	03	23	03	0	44	2	40	4	38	6	46
23	21	07	23	06	0	48	2	44	4	42	6	50
24	21	11	23	10	0	52	2	48	4	46	6	54
25	21	15	23	13	0	55	2	51	4	50	6	58
26	21	19	23	17	0	59	2	55	4	54	7	02
27	21	23	23	21	1	03	2	59	4	58	7	06
28	21	27	23	25	1	06	3	03	5	02	7	10
29	21	31			1	10	3	07	5	06	7	14
30	21	35			1	14	3	10	5	11	7	19
31	21	38			1	17			5	15		

Dayes.	July		August		Septemb.		October		Novem.		Decemb.	
	Suns right ascen.		Suns right ascen.		Suns right ascen.		Suns right ascen.		Suns right ascen.		Suns right ascen.	
	H	M	H	M	H	M	H	M	H	M	H	M
1	7	23	9	25	11	19	13	08	15	07	17	15
2	7	27	9	29	11	23	13	12	15	11	17	20
3	7	31	9	33	11	26	13	15	15	15	17	25
4	7	35	9	37	11	30	13	19	15	19	17	29
5	7	39	9	40	11	33	13	22	15	23	17	34
6	7	43	9	44	11	37	13	26	15	27	17	38
7	7	47	9	48	11	41	13	30	15	31	17	42
8	7	51	9	51	11	44	13	34	15	36	17	47
9	7	55	9	55	11	48	13	38	15	40	17	51
10	7	59	9	58	11	51	13	41	15	45	17	56
11	8	63	10	02	11	55	13	45	15	49	18	00
12	8	07	10	06	11	59	13	49	15	53	18	05
13	8	11	10	10	12	02	13	53	15	58	18	09
14	8	15	10	14	12	06	13	57	16	02	18	14
15	8	19	10	17	12	09	14	00	16	07	18	19
16	8	23	10	21	12	13	14	04	16	11	18	24
17	8	27	10	25	12	17	14	08	16	15	18	28
18	8	31	10	28	12	20	14	12	16	19	18	33
19	8	35	10	32	12	24	14	16	16	23	18	37
20	8	39	10	35	12	27	14	20	16	28	18	41
21	8	43	10	39	12	31	14	24	16	32	18	15
22	8	47	10	43	12	35	14	28	16	36	18	49
23	8	51	10	46	12	38	14	32	16	40	18	54
24	8	55	10	50	12	42	14	36	16	44	18	58
25	8	58	10	53	12	45	14	39	16	49	19	03
26	9	02	10	57	12	49	14	43	16	53	19	07
27	9	06	11	01	12	53	14	47	16	57	19	11
28	9	10	11	04	12	57	14	51	17	02	19	16
29	9	14	11	08	13	01	14	55	17	06	19	20
30	9	17	11	11	13	04	14	59	17	11	19	25
31	9	21	11	15			15	03			19	30

To know the hour when any Star cometh upon the Meridian.

The Rule.

FIrſt ſeek the *Right Aſcenſion* of that Star required in the fore-going Tables (of the *Right Aſcenſion* of the Stars) and alſo of the *Right Aſcenſion* of the Sun, from the *Right Aſcenſion* of the Star. (But when the *Right Aſcenſion* of the Star, is leſs then the *Right Aſcenſion* of the Sun. Then add 24 hours thereto, and then the remainder will ſhew you the hour Afternoon, when the Star cometh upon the Meridian, and if it do exceed 12 hours, then ſubſtract 12 hours there-from, and the remainder ſhall ſhew the hour and minute of the Stars coming upon the Meridian after midnight.

1. Example.

Upon the 10th of *April*, I would know when the *Lyons Heart* cometh upon the Meridian. Therefore if you look in the Tables of *Right Aſcenſion* for that Star, you will find it to be 9 hours 50′. Then look in the Tables of *Right Aſcenſion* of the Sun, and right againſt the 10th of *April*, you will find the *Right Aſcenſion* of the Sun to be 1 hour 45 minutes, which ſubſtract from the *Right Aſcenſion* of the Star, and there remaineth 7 hours 56 minutes, which is the true time that the Star cometh to the Meridian Afternoon.

2. Example.

Upon the fifth of *November*, I deſire to know when the *Bulls Eye* cometh upon the Meridian: The *Right Aſcenſion* thereof by the Tables, you will find to be 4 hours 16 minutes: The *Right Aſcenſion* of the Sun that day is 15 hours 23 minutes. Therefore becauſe the *Right Aſcenſion* of the Star is leſs than the *Right Aſcenſion* of the Sun, I add 24 hours to the *Right Aſcenſion* of the Star, which maketh 28 hours 16 minutes: From which ſubſtract the *Right Aſcenſion* of the Sun, which is 15 hours 23 minutes, and the remainder is 12 hours 16 minutes.

From which I ſubſtract the 12 hours, and the remainer is 16 minutes after *Midnight* when the ſaid Star cometh upon the *Meridian*.

And here note, That the Tables of the *Right Aſcenſion* of the Sun, are calculated for Noon time every day; and that it doth increaſe by 4 minutes every day; ſo that it may be proportioned for every 6 hours, to allow one minute for the Stars coming to the *Meridian* after the Sun.

The Doctrine of Plain Triangles.

CHAP. V.

Of the Calculation of Plain Triangles, with their Conſtruction and Application to Nautical Queſtions.

I.

A Plain Triangle is contained under 3 right Lines, and is either Right-Angled or Oblique.

II. In all Plain Triangles, two Angles being given the third is alſo given: And one Angle being given, the other two are alſo given; becauſe the 3 Angles together are equal to two right Angles.

Therefore in a Plain Right-Angled Triangle, one of the Acute Angles is the Complement of the other.

III. In the ſolution of Plain Triangles, the Angles only being given, the ſides cannot be found, but only the reaſons of the Sides: It is therefore neceſſary that one of the ſides be known.

IV. In a Right-Angled Triangle two terms (beſides the Right Angle) will ſerve to find the third; ſo the one of them be a Side.

V. In Oblique Angled Triangles there muſt be three things given to find a fourth.

VI

VI. In Right-angled Plain Triangles there are ſeven Caſes, and five in Oblique. For the Solution of which, theſe 4 *Axiomes* are ſufficient.

Axiome I.

Of Right Angled Triangles.

In all Plain Right-angled Triangles any of the Sides may be put as Radius; and the other Sides will be as Sines, Tangents or Secants.

Axiome II.

In all Plain Triangles the Sides are in ſuch proportion one to another, as are the Sines of their oppoſite Angles.

Axiome III.

In all plain Triangles, as the ſum of two Sides is to their difference, ſo is the Tangent of their half Sum of their two oppoſite Angles, to the Tangent of the difference of either of them, above or under the half Sum.

Axiome IV.

In Oblique Triangles, as the true Baſe is in proportion to the Sum of the other Sides, ſo is the difference of theſe Sides, to the difference of the Segments of the Baſe.

In Right-angled Plain Triangles the Sides comprehending the Right Angle are called the *Leggs*, and the Side ſubtending the right Angle is called the *Hypothenuſe*.

Caſe I.

The Angles and Baſe given to find the Perpendicular.

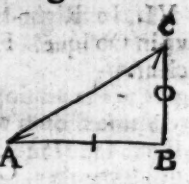
Dat. the Angles A B C, and the Side A B, require the Side B C.

Or *Nautically* thus,

The Courſe and Departure from the *Meridian* being given to find the difference of Lattitude.

Courſe the 5th Rhomb (from the *Meridian*) or 65^{d} $15'$, departure 90 Leagues.

In the annexed Triangle, let the Angle at A be the Complement of the Course from the *Meridian*, which is 33^d, $45'$; and the Side A B, 90 Leagues. The departure from the Meridian; the side B C the diff. of Lat. is required.



The Proportion by the Tables of artificial Sines, Tangents and Logarithms is,

As the Angle at C which is the Sine of the Course 56^d, $15'$	9, 91984
is to the Side A B 90 Leagues, the Departure,	1, 95424
so is the Angle at A the Co. Sine of the Course 33, 45.	9, 74473
	11, 69897
to the Logarithm of the side C B 60 Leagues	1, 77913

A General Rule for the Working of all such Proportions by the Tables of Artificial Sines and Logarithms, viz.

Add the second and third Numbers together, and from the Sum of them substract the first number, so shall the remainer answer your question demanded; as by the former work you may perceive.

For first in the Tables you look for the Sine of 56^d, $15'$, which is, 9, 91984, which number you first set down (which is the first term) then in the Logarithms, you look for the Logg. of 90 Leagues, which is, 1, 95424, which number I set right under the first, (which is the second term.) Then lastly, I look for the Sine of 33^d, $45'$, which is 9, 74473, which I likewise set down under the two former numbers (which is the 4th term.) And them draw a Line under them, and add the two last numbers together, and the sum is 11, 69897. Then draw a Line under the uppermost number, then substract the uppermost number, from the sum of the other two; and the remainer is, 1, 77913; which being sought for in the Tables of Logarithms, the nearest will be found to be the Logg. of 60 Leagues: which was the third number required.

The same manner of work is to be observed in all the rest of the following Cases.

To

To perform the ſame work by the Line of Sines and Numbers on Gunters Rulers.

And the Proportion is,

As the Sine of the Angle at C 56d, 15′.
is to the Side A B, 90 Leagues,
ſo is the Angle at A, 33d, 45′,
to the Side B C, 60 Leagues.

Therefore if you ſet one foot of your Compaſſes at 56d, 15′. in the Line of Sines, and extend the other foot to 90 in the Line of Numbers (croſs-wiſe) the ſame extent of the Compaſſes will reach from the Sine of 33d, 45′, in the Line of Sines to 90, in the Line of Numbers; or otherwiſe extend the Compaſſes from the Sine of 56°, 15′, to 33d, 45′, in the Line of Sines; the ſame extent will alſo reach from 90 in the Line of numbers to 60, as before.

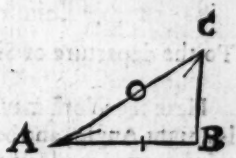
I have been the larger in the explanation of this Caſe, becauſe in all thoſe following I ſhall be the more brief.

Caſe II.

The Angles and Baſe given to find the *Hipothenuſal*,
Dat. the Angles B A C, Side A B, requ. the Side A C.
Or, *Nautically* thus.

The Courſe and Departure from the *Meridian* given to find the Diſtance run.

Courſe the 5th Rhomb, Departure 90 Leagues.



Then the Proportion is,

As the Angle at C, 65 deg. 15 min.	9, 91984
is to the Side A B, 90 Leagues,	1, 95424
ſo is Radius	10,
	11, 95424
To the *Hipothenuſal* 180 Leagues.	2, 03440

Performed by Gunters *Ruler.*

Ex-

Extend the Compaſſes from 56 deg. 15 min. (on the Line of Sines) to 90 on the Line of Numbers (croſs-wiſe) the ſame extent the ſame way will reach from the Sine of 90, in the Line of Sines, to 180 in the Line of Numbers, which is the Diſtance run.

Or you may extend the Compaſſes, from the Sine of 56 deg. 15 min. to 90 in the Line of Sines; the ſame extent will reach from 90 in the Line of Numbers to 180, as before.

Caſe III.

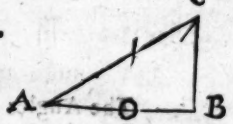
The Angles and *Hipothenuſal* given to find the Baſe.

Dat. the Angles A B C, Side A C, requ. the Side A B.

Or *Nautically* thus,

The Courſe and Diſtance being given, to find the Departure from the *Meridian*.

Courſe the 5th Rhomb, Diſtance 108 Leagues.



And the Proportion is,

As Radius,	10, 00000
is to the *Hipothenuſal*, or Diſt. run 180, as the Side A C,	2, 03342
ſo is the Angle at C, 56 deg. 15 min.	9, 91984
	11, 95326
To the departure or Side A B, 90 Leagues,	

Here the Work may be ſomewhat abreviated becauſe the Angle at B is a right Angle, and being the firſt term; ſo that when the ſecond and third terms are added together, the firſt is eaſily ſubſtracted from it, by cutting off or cancelling the Figure next your left hand, as you may ſee in the Example. And ſo you may do at any time when the Radius is in the firſt place.

Performed by *Gunters* Ruler.

Extend the Compaſſes from the Sine of 90 degrees, in the Line of Sines, to 108 in the Line of Numbers; the ſame Extent will reach from the Sine of 56 degrees 15 minutes, to 90 Leagues in the Line of Numbers.

Or

Or thus; Extend the Compaſſes from the Sine of 90 degrees to the Sine of 56 degrees, 15 minutes in the Line of Sines; the ſame extent will reach from 108 to 90 in the Line of Numbers.

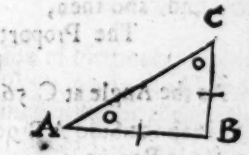
Caſe IV.

The Baſe and Perpendicular being given, to find an Angle.

Dat. Sides AB & BC, required the Angles A or C,

Or *Nautically* thus.

The difference of Lattitude and Departure from the *Meridian*, given to find the Courſe.



Difference of Lat. 60 Leagues (or 3 Degrees.)
Departure from the *Meridian* 90 Leagues.

And the Proportion is,

As the Side AB, in the annexed Triangle, which is 90 Leagues,	1, 954242
is in Proportion to Radius,	10,
ſo is the Side CB 60 Leagues	1, 778151
	11, 778151
to the Tangent of the Angle at A, 33 deg. 41 min.	9, 823909

The Reaſon of this Difference that appears in the laſt Operation, is occaſioned by reaſon of the Omiſſion of ſome fractional parts in the ſides found, which might have been corrected by the part proportional: But becauſe in thoſe Operations there is not that exactneſs required, I therefore forbear enlarging thereon.

Performed by *Gunters* Ruler.

Extend the Compaſſes from 108, in the Line of Numbers, to 90; the ſame extent will reach from the Sine of 90, in the Line of Sines, to 56 degrees, 15 min. the Angle at C, which is the Sine of the Courſe.

Case v.

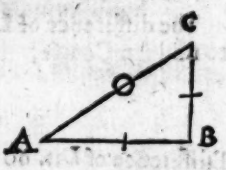
The Base and Perpendicular given to find the *Hipothennsal*.

Dat. Sides A B & A C, required the Sides A C.

Or *Nautically* thus.

The difference of Lattitude and the Departure from the *Meridian* being given, to find the Distance run.

Difference of Lattitude 60 Leagues, Difference of Longitude 90 Leagues.



Therefore by the 4.th Case an Angle must first be found, and then,

The Proportion will be

As the Angle at C 56 deg. 15 min.	9, 919846
is to the Side A B 90 Leagues.	1, 954242
so is Radius,	10,
to the Side A C, the Dist.	11, 954242
run 180 Leagues.	2, 034396

By *Gunters* Ruler thus.

First find the Angle by the Rule in the last Case, which suppose to be the Angle at A 56 deg. 15 min.

Therefore extend the Compasses in the Line of Sines from the Sine of 56 deg. 15 min. unto 90 Leagues in the Line of Numbers; the same extent being applied from the Sine of 90 in the Line of Sines will reach to 108 in the Line of Numbers.

Case vi.

The Base and *Hypothennsal* given to find an Angle.

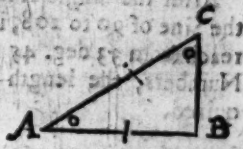
Dat. Sides A B & A C, required the Angles A or C.

Or *Nautically* thus.

The departure from the *Meridian* and Distance run, given to find the Course.

Departure

Departure 90 Leagues distance run, 108 Leagues in the annexed Triangle,



And the Proportion is,

As the Hipothenusal,

which is the distance run 108 Leagues 2,03342
is in proportion to Radius, 10,
so is the Side A B, 1,95424
Departure from the Meridian 90 Leagues. 11,95424
to the Angle at C, 65 deg. 15 min. 9,92082

By *Gunters* Ruler thus.

Extend the Compasses from 180 in the Line of Numbers to 90 in Line of Sines: The same extent will reach from 90 in the Line of Numbers, to 56 deg. 15 min. in the Line of Sines, which is the Angle at C.

Case VII.

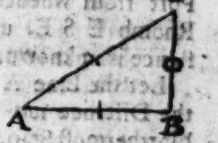
The Base and *Hypothenusal* given, to find the *Perpendicular*.

Dat. Sides A B & A C, required Side B C.

Or *Nautically* thus.

The Departure from the Meridian, and the Distance run, being given, to find the difference of Latitude.

Departure 90 Leagues, Dist. run 108 Leagues.



First find the Angle at A by the 6th Case,

And then the Proportion is,

As Radius, 10,
is in proportion to the Side A B, the Departure from the Meridian 90 Leagues, 1,954243
so is the Tangent of the Angle at A, Comp. of the Course 33d, 45′, 9,824892
to the Side B C, Diff. of Lat. 60 Leagues, 11,779134

By *Gunters* Ruler thus.

After the Angle at A is found, as before, extend the Compasses from the Sine of 90 to 108, in the Line of Numbers; the same extent shall reach from 33 deg. 45 min. in the Line of Sines, to 60 in the Line of Numbers, the length of the side B C, the difference of Latitude required.

Case VIII.

The Angles of a Triangle with one of the Sides being given to find any of the other two Sides.

Dat. Angle at { A 33 45 / B 45 00 / C 101 15 } Required Side C B, & A B.

Or *Nautically* thus.

Side A C 40 miles.

Two Ships sailing from one and the same Port, one sailes E by S, the distance unknown: the other sailes E N E, 40 miles, and then they bear N W by W, and S E by E, one of another.

The Distance between the two Ships is demanded, and also how far the Southermost Ship is gone from the Port from whence they departed.

Therefore in the annexed Triangle, let the Letter A denote the Port from whence they depart: Let the Line A B represent the Rhomb E S E, upon which the Southermost Ship sailed, whose distance is unknown.

Let the Line A C, represent the E N E Point of the Compasses; the Distance run upon that Point is 40 miles; C the place of the Northermost Ship, and B the place of the Southermost Ship, they bear N W by W, S E by E, one of another; Therefore their distance asunder, the Side C B is required, and also the Side A B, which is the distance sailed by the Southermost ship.

Therefore in this Question you may take notice, that all the Angles are given, and one of the Sides to find the other sides.

For the Angle at A is 3 Points of the Compass, or 33d. 45′. and the Angle at B 45 deg. So that the sum of those two Angles, which is 87 deg. 45 min. which being substracted from 180 deg. the remainer is 101 deg. 15 min. the Angle at C.

The

The Proportion is, by the Artificial Tables of Sines and Logarithms,

As the Angle at B 45 deg. 00 min.	9, 84948
is to the Side A C, 40 miles,	1, 60206
so is the Angle at A, 33 deg. 45 min.	9, 74478
	11, 34679
to the side C B 31 miles and somewhat more, their distance asunder required.	1, 49731

Then to know the distance of the Southermost Ship, how far they have sailed from the Port from whence she departed, which is the Side A B, and the Proportion is,

As the Angle at B, 45 deg. 00 min.	9, 84948
is to the Side A C 40 miles,	1, 60206
so is the Angle at C, 101 deg. 15 min.	9, 99157
(or 78 deg. 45 min.)	
to the Side A B. 55 miles	11, 59363
	1, 74415

Performed by Gunters *Rule.*

Extend the Compasses from 45 deg. in the Line of Sines, the Angle at B, to 40 in the Line of Numbers, which is the Line A C, the same extent shall reach in the Line of Sines from 33 deg. 45 min. the Angle at A, to 31 miles and a ½ the Line C B.

And to find the Side A B, the same extent of the Compasses shall reach from (101 deg. 15 min. the Angle at C, or the Complement thereof to 180 which is 78 deg. 45 min.) to 55 in the Line of Numbers, the distance sayled by the Southermost Ship.

Case IX.

Two Sides of a Triangle being given with an Angle Opposite to one of them: to find an Angle opposite to the other of them, and the other side.

Dat. Side A B 100 miles, Side A C 80 miles, Angle B 45 deg. 00 min. required the Angle at C.

Or, *Nautically* thus:

Suppose there are two Ports that lie East and West one of another, 100 miles distance.

A Ship being at the Eastermost Port, sailes out between the North and East 80 miles, and another Ship in the Westermost Port, sailes N. West, the distance unknown, until she meets with the other Ship. Now the question is what Angle is made between their two Courses, and consequently what Course the Eastermost Ship stear'd.

Therefore in the annexed Triangle, let A represent the Eastermost port & B the Westermost Port, the Line A B their distance 100 miles, the Angle at B representing the quantity of the Rhomb, which is 4 points, or 45 deg. being the Northwest Point of the Compass.

And the Line A C, the distance run by the other Ship; C the place of meeting. The question is, What the Angle at A is, and consequently the Eastermost Ships Course, and also the distance run by the Westermost Ship?

Therefore the Proportion is,

As the Side A C, the Distance of the Eastermost Ship, Eighty miles,	1, 90309.
is to the Angle at B, the Course sailed by the Westermost Ship 45 deg. 00 min.	9, 84948.
so is the Side A B, the Distance of the two Ports one hundred miles,	2, 00000.
	11, 84948.
	9, 94639.

to the Angle intercepted between their two Courses.

And because the Angle at C is obtuse, which is the Sine of 62 deg. 6′ it must be substracted from 180, and there remains 117^{d} 54′, the Angle at C; which Angle being added to 45, the Angle at B, makes 162^{d} 54′, the which being taken from 180 deg. there remains 17 deg. 06′, the Angle at A, the Course made by the Eastermost ship.

And

And to find the Distance run by the Westermost ship,

The Proportion is,

As the Angle at B 45 deg. 00 min.	9, 849485
is to the Side A C, 100 miles,	2, 000000
so is the Angle at A, 17 deg. 6 min.	9, 468406
	11, 468406
to the Side B C, 41 miles,	1, 618921

Performed by *Gunters* Ruler.

Extend the Compasses from 45 in the Line of Sines, to 100 in the Line of Numbers, the same extent the same way shall reach from 17 degrees, 6 minutes in the Line of Sines, to 41 in the Line of Numbers.

Or if you Extend the Compasses from 45 in the Line of Sines, to 17 degrees 6 minutes in the same Line, the same extent shall reach from 100 in the Line of Numbers to 41, the length of the Side B C.

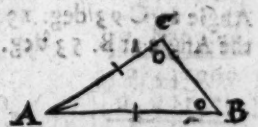
Case x.

Two Sides with their contained Angle being given, to find the other Angle.

Dem. Side A B, 25 miles, Side A C, 20 miles, Angle at A 33 deg. 45. min. required the Angles at B & C. Sum 45 diff. 5.

Or *Nautically* thus,

Suppose two Ships being in a certain Road, they both weigh Anchor, and one sailes S and by East, 20 miles, and the other sailes S S W 25 miles; Their bearing one from another is required.



Therefore in the annexed Triangle, let the Side A B represent the S and by East point of the Compass, the Course sailed by the Westermost Ship, whose distance run upon that point is 25 miles: And let the Side A C represent the S S W Point of the Compass, and the Distance run upon that Point is 20 miles; so that there is contained between those two Courses, three Points of the Compass, which is 33 degrees, 45 min.

45 min. therefore one Ship being at B, and the other at C, their bearing one from another is required.

Note that the Sum of the two unknown Angles is 146 degrees, 15 minutes:

And the Proportion is,

As the sum of the Sides given (A B + A C, 45 miles,	1, 653212
is in Proportion to the Difference (A B — A C, 5 miles,	0, 698970
so is the Tangent of the half sum of their two opposite Angles ½ E + D, 73 deg. 7 min.	10, 517833
	11, 216803
to the Tangent of an Angle found, 20 deg. 6 min.	9, 563598

which added to the half sum, makes the greater of the Angles required, 93 d. 13 m. the Angle at C; or substracted, leaves the lesser, 53 deg. 1 min. the Angle at B.

Performed by *Gunters* Ruler.

Extend the Compasses from 45 (the Sum of the two Sides) in the Line of Numbers; unto 5 the difference of the two Sides; the same Extent apply from the Tangent of 45 degrees downwards, causing the moveable point to fall upon the same Line; which being done, and the movable point remaining there fixed, close the Compasses until the other point may rest upon 73 deg. 7 min. (the Tangent of the half sum of the two unknown Angles.)

And having the Compasses so extended, apply that extent downwards, setting one foot in the Tangent of 45, the other will reach to 20 deg. 6 min. which add to the Tangent of the half sum, and it will give the Angle at C 93 deg. 13 min. and being substracted therefrom leaves the Angle at B. 53 deg. 01 min.

Case XI.

Two Sides of an Oblique Triangle, and their contained Angle being given, to find the third Side.

Dat. the Sides A B and A C, and the Angle at A 22 deg. 30 min. requ. the Side B C.

Or

Or *Nautically* thus;

Suppose an Island to bear from me S W & by West 335 miles, the wind taking me short, I can lye no nearer than S W about a quarter Southerly, upon which Course I sail 271 miles; I now demand the distance of the said Island.

Therefore in the annexed Triangle, let the Letter A represent the place of my Ship, B the Island, and the Line A B the S W and by West point of the Compass, and the distance of the Ship from the Island from A to B, 335 miles, and let the Line A C represent S W, and somewhat more Southerly, and the distance run upon that Course 271 miles the Angle at A, which is 14 deg. 40 min. The Side B C, the Distance of the Island from the Ship which is demanded.

Therefore the Proportion (first for finding of the Angle) by the last Case is

As the Sum of the Sides given (A B + A C) 606. miles,		2, 782472
is in proportion to their difference A B — A C 64, miles,		1, 806180
so is the Tangent of the half Sum of the two unknown Angles + ½ B + C	82d. 40′	10, 890440
		12, 696620
to the Tangent found 39 deg. 22 min.		9, 914148

which being substracted from the Tangent of the half sum, leaves 43 deg. 18 min. the Angle at B.

Having first found the Angle, you may proceed to find the Side by the 8th Case,

And the Proportion is,

As the Angle at B 43 deg. 18 min.	9, 836209
is to the Side A C, 271	2, 432969
so is the Angle at A 14 deg. 40 min.	9, 403455
	11, 836424
to the Side B C 100,	2, 000255
the Side B C required.	

By

By *Gunters* Ruler.

First to find an Angle by the 10th Case.

Extend the Compasses upon the Line of Numbers downwards (from the sum of the sides) 606 (unto their difference) 64: then apply that extent from 45 deg. 0 min. in the Line of Tangents downwards, causing the movable point to fall upon the same Line, and where it falls keep it unmovable; and close the Compasses until the other point will rest upon 82 deg. 40 min. the Tangent of the half sum; and having the Compasses so extended, apply that extent downwards from 45 deg. and the other will reach to 39 deg. 22 min. which being substracted from 82 deg. 40 min. the remainer is 43 deg. 18. min. the Angle at B.

To find the Side.

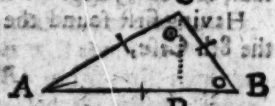
Extend the Compasses from 43 deg. 18 min. the Angle at B (upon the Line of Sines) unto 271 (in the Line of Numbers) the same extent shall reach from the Sine of 14 deg. 40 min. to 100 in the Line of Numbers, the Side B C required.

Case XII.

Three Sides of an Oblique Triangle being given: to find an Angle.

Dat. the three Sides required, an Angle.

Nautically thus.



There are two Ports in one and the same Parallel, Dist. 64 Leagues, they are both bound to a certain Island more Southerly, distant from the Eastermost of these Ports 47 Leagues, and from the Westermost of them 34 Leagues; I demand the Course from the Eastermost Port to the Island.

Therefore in the annexed Triangle, let the Side A B represent the distance of the two Ports 64 Leagues, the Side A C the Eastermost ships Course 47 Leagues, and the Side B C 34 Leagues; there is required the Angle at A, or the Complement thereof.

First,

First, by the fourth Axiome before-going, you must resolve it into two right-angled Triangles; thus,

As the whole Base A B, the dist. of the Ports, 64,	1, 806180
is to the sum of the sides A C B C 81,	1, 908485
so is the differ. of the Sides A C and B C, 13.	1, 113943
	3, 022328
to a 4th number, 16 $\frac{414}{1000}$	1, 216148

which being added to the whole Base A B makes $64 + 16\frac{414}{1000} = 80\frac{414}{1000}$

the half of which is, $40\frac{207}{1000}$

which is the distance from A to D, where the perpendicular must fall.

Then by the 6th Case.

As A C 47 Leagues	1, 67209
is to Radius	10,
so is A D 40, $\frac{207}{1000}$	11, 60452
to the Sine Complement of A 58 deg. 51′,	9, 93243

that is South-west and by West 2d. 36′. Westerly, which is the Course, from the Eastermost part of the Island.

By *Gunters* Ruler.

Extend the Compasses from 64 the whole Base A B, unto 81 the sum of A C, B C (upon the Line of Numbers) the same extent shall reach (from 13 the difference of A C and C D) to 16, $\frac{414}{1000}$, the half whereof is A D 40, $\frac{207}{1000}$.

Then by the 6th Case,

Extend the Compasses from 47 Leagues, the Side A C, (in the Line of Numbers) unto 90 in the Line of Sines, the same extent the same way, shall reach from 40, $\frac{207}{1000}$, in the Line of Numbers, to 58d 51′ in the Line of Sines, which is the Sine Complement of the Course, the Angle at A.

Spherical Triangles.

CHAP. VI.

Of the Affections of Spherical Triangles.

I.

A *Spherical Triangle* is that which is described on the surface of the Sphere.

2. The Sides of a *Spherical Triangle* are the Arches of three great Circles of the Sphere, mutually intersecting each other.

3. The Measures of *Spherical Triangles* are Arches of great Circles, described from the Angular Point, between the Sides of the Angles, those Sides being continued to Quadrants.

4. Those are said to be great Circles which bisect the Sphere.

5. Those Circles, which cut each other at right Angles, the one of them passeth through the Poles of the other, and the contrary.

6. In every *Spherical Triangle* each side is less than a Semicircle.

7. In every *Spherical Triangle* any two Sides are together greater than the third.

8. The sum of the Sides of a *Spherical Triangle* are less than two Semicircles.

9. If two Sides of a *Spherical Triangle* be equal to a Semicircle, the two Angles at the Base shall be equal to two right; if they be less than a Semicircle, the two Angles shall be less than two right: but if greater than a Semicircle, the two Angles shall be greater than two right.

10. The Sum of the three Angles of a *Spherical Triangle* are greater than two right Angles, and less than six.

11. Two

11. Two Angles of any *Spherical Triangle* are greater than the difference between the third Angle and a Semicircle alſo.

12. Any Side being continued, the Exterior Angle is leſs than the two Interior oppoſite ones.

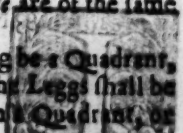
13. In any *Spherical Triangle* the difference of the ſum of two Angles and a whole Circle, is greater than the difference of the third Angle and a Semicircle.

14. In any *Spherical Triangle* one Side being produced, if the other two Sides be equal to a Semicircle, the outward Angle ſhall be equal to the inward oppoſite Angle upon the Side produced: if they be leſs than a Semicircle, the outward Angle ſhall be leſs than the inward oppoſite Angle.

15. A *Spherical Triangle* is either Right or Oblique Angled.

16. A Right Angled *Spherical Triangle* is that which hath one Right Angle at the leaſt.

17. The Legges of a right angled *Spherical Triangle* are of the ſame Affection with their oppoſite Angles.



18. In a right angled *Spherical Triangle* if either Leg be a Quadrant, the *Hypothenuſe* ſhall be alſo a Quadrant; but if both the Leggs ſhall be of the ſame Affection the *Hypothenuſe* ſhall be leſs than a Quadrant, or if different then greater, and the contrary.

19. In a right angled *Spherical Triangle* if either of the Angles at the *Hypothenuſe* be a right Angle, the *Hypothenuſe* ſhall alſo be a Quadrant; but if both ſhall be of the ſame Affection, it ſhall be leſs, if of different it ſhall be greater, and the contrary.

20. In a right angled *Spherical Triangle* either of the Oblique Angles is greater than the Complement of the other, but leſs than the difference of the ſame Complement to a Semicircle.

21. An Oblique *Spherical Triangle* is either Acute or Obtuſe.

22. An Acute angled *Spherical Triangle* hath all its Angles Acute.

23. An Obtuſe angled *Spherical Triangle* hath all its Angles either Obtuſe or mixt, *viz.* Acute or Obtuſe.

24. In any *Spherical Triangle* whoſe Angles are all Acute, each ſide is leſs than a Quadrant.

25. In any Oblique angled *Spherical Triangles*, if the Angle at the Baſe be of the ſame Affection, the perpendicular drawn from the vertical Angle ſhall fall within, if of different, without.

Of Right Angled Spherical Triangles.

CHAP. VII.

Of the Calculation of Right Angled Spherical Triangles.

IN all *Spherical Triangles* there are 28 Cases. Sixteen in Rectangular, and Twelve in Oblique Angular. Whereof all the Rectangular, and ten of the Oblique Angular may be resolved by these two *Axioms* following.

Axiome I.

In all *Spherical Rectangled Triangles*, having the same acute Angle at the Base, the Sines of the *Hypothenuse's* are proportionable to their Perpendicular.

Axiome II.

In all *Spherical Rectangled Triangles* having the same acute Angle at the Base, the Sines of the Bases, and the Tangents of the Perpendiculars are proportional.

That all the Cases of a *Right Angled Spherical Triangle* may be resolved by these two *Axiomes*. The several parts of the *Spherical Triangle* proposed, must sometimes be continued to *Quadrants*, that so the *Angles* may be turned into *Sides*, the *Hypothenuses* into *Bases* and *Perpendiculars*, and the contrary. By which means the Proportions are to the Parts of the *Triangle* given, in stead of *Sines* do sometimes fall in *Co-Sines*: and sometimes in *Co-Tangents* in stead of *Tangents*. Such Conversions as do for the most part change their Proportion, are noted with their Complements (*viz.*) the *Hypothenuse*, and both the acute

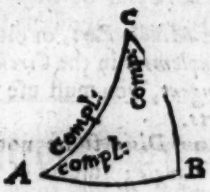
Angles:

Angles; but the *Sides* containing the right *Angle*, are not so noted. And these be called, *the five Circular parts of a Triangle*, amongst the which, the right *Angle* is not reckoned, and therefore the two *Sides* which do contain it, are supposed to be joyned together.

Of these five Circular parts one is alwayes in the middle, and two of the five are adjacent to that middle part, and the other two are disjunct. The Parts adjacent are called, *Extreams Adjacent*; and the parts disjoyned are called, *Extreams Disjunct*

Each of these circular parts may by supposition be made the middle part, and then the two Circular parts which are next to that, which is by supposition made the middle, are the *Extreams Conjunct*; the other three, remote from the other parts assumed are the *Extreams Disjoyned*.

As in the Triangle A B C, if Comp. A C be made the middle part, Comp. A and Comp. C are the *Extreams Conjunct*, and the sides A B and B C are the *Extreams Disjunct*; and so of the rest, as in the Table following.



Mid. part.	*Extr. Conj.*	*Extr. Disj.*
Leg. A B	*Comp.* A *Leg.* B C	*Comp.* A C *Comp.* C
Comp. A.	*Comp.* A C *Leg.* A B	*Comp.* C *Leg.* B C
Comp. A C	*Comp.* A *Comp.* C	*Leg.* A B *Leg.* B C
Comp. C	*Comp.* A C *Leg.* B C	*Comp.* A B *Leg.* A B
Leg. B C	*Comp.* C *Leg.* B C	*Comp.* A *Comp.* A C

The parts of a *Right Angled Spherical Triangle* being thus distinguished into five Circular parts (besides the right *Angle*) the three parts

parts remote from the right *Angle* being noted by their *Complements*, and of these five Circular parts, one is accounted the *Middle*, the other *Extreams Adjacent*, or *Disjunct*; these being invented for the better help of memory, and therefore the more eaſie in reſolving of all *Spherical Triangles*, obſerve this Catholick and Univerſal Propoſition.

The *Sine* of the *Middle Part* and *Radius*, are reciprocally proportional with the *Tangents* of the *Extreams Conjunct*, and the *Co-Sines* of the *Extreams Disjunct*.

That is, As *Radius* to the *Tangent* of one of the *Extreams Conjunct*, ſo is the *Tangent* of the other *Extream Conjunct* to the *Sine* of the *Middle Part*.

And alſo, as *Radius* to the *Co-Sine* of one of the *Extreams disjunct*, ſo is the *Co-Sine* of the other *Extream Disjunct*, to the *Sine* of the *Middle Part*.

Therefore if the *Middle Part* be ſought, the *Radius* muſt be in the firſt place; if either of the *Extreams*, the other *Extream* muſt be in the firſt place.

Only note, That if the *Middle Part*, or either of the *Extreams Conjunct* be noted with its *Complement* in the *Circular parts* of the *Triangle*, inſtead of the *Sine* or *Tangent*, you muſt uſe the *Co-Sine* or *Co-Tangent* of ſuch *Circular part* or *parts*.

If either of the *Extreams Disjunct* be noted by its *Complement*, in the *Circular parts* of the *Triangle*; inſtead of the *Co-Sine*, you muſt uſe the *Sine* of ſuch *Extream Disjunct*.

That the Directions may be the better underſtood, there is in the Table following ſet down the *Circular parts* of a *Triangle* under their reſpective Titles, whether they be taken for the *Middle part*, or for the *Extreams*, whether *Conjunct* or *Disjunct*; and unto thoſe parts there is prefixed the *Sine* and *Co-Sine*, the *Tangent* or *Co-Tangent*, as it ought to be by the former Rules.

Mid. Part.	*Extr. Conj.*	*Extr. Disj.*
Sine A B	*Co-Tang.* A *Tang.* B C	*Sine* A C *Sine* C
Co-Sine A	*Co-Tan.* A C *Tan.* A B	*Sine* C *Co-Sin.* B C
Co-Sin. A C	*Co-Tan.* A *Co-Tan.* C	*Co-Sin.* A B *Co-Sin.* B C
Co-Sin. C	*Co-Tan.* A C *Tang.* B C	*Sine* A *Co-Sin.* A B
Sine B C	*Co-Tan.* C *Tang.* A B	*Sine* A *Sine* A C

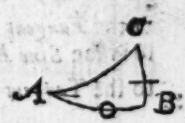
These things premiſed, the ſeveral Caſes ſhall be ſet down with their Analogies, by which they may be ſolved according to this Catholick Propoſition of *Right Angled Spherical Triangles* firſt, and then of *Oblique*.

Of Right Angled Spherical Triangles.

Probleme I.

A *Leg* with an *Angle* oppoſite thereunto being given, to find the other *Leg*; if it be known whether the *Hypothenuſe* or the other *Angle* be more or leſs than a *Quadrant*.

In the annexed *Right Angled Spherical Triangle* A B C, the *Leg* A B, or *Middle part*, is inquired.



The given { *Leg*, A B C, 22d 53′ } are *Extream*,
{ *Ang. Comp.* A B C 30. } *Conjunct.*

Terms of Proportion.

As *Radius* is to the *Tangent* of the *Oblique Angle* given,
ſo is the *Tangent* of the *Leg* given, to the *Sine* of the *Leg* inquired.

As

As *Radius* 90 deg.	10,
is to the *Co-Tang.* A 30d 00′	10, 238561
ſo *Tang.* B C, 22d 53′	9, 625529
to Sine A B 46 deg. 59′	9, 864090

Performed by *Gunters* Ruler.

Extend the Compaſſes from the *Sine* of 90 (in the Line of Sines) unto 30 in the Line of *Tangents*, the ſame extent ſhall reach from 22 deg. 53 min. to 46 deg. 59 min in the Line of Sines.

Probleme 2.

A *Leg* and an *Angle* being given, to find the other *Leg*.

In the annexed *Rectangular Spherical Triangle* A B C, the *Leg* B C one of the *Extreams Conjunct* is inquired.

The given { *Leg.* A B, 47 deg. 00 min. } *Middle part.*
{ *Ang. Com.* A 30 deg. } the other *Extr. Conj.*

Terms of Proportion,

As *Radius* is to the *Tangent* of the *Angle* given,
ſo is the *Sine* of the *Leg* given, to the *Tangent* of the *Leg* inquired.

Illuſtration by artificial Numbers.

As *Radius* 90 deg.	10,
to the *Tangent* of A 30 deg. 00′	9, 761439
ſo is the *Sine* A B, 47 deg.	9, 664127
to the *Tangent* B C, 22 deg. 53 min.	9, 625566

Performed by Guntets *Ruler.*

Extend the Compaſſes from the Sine of 90 in the Line of Sines, unto 30 in the Line of Tangents, the ſame Extent will reach from the 47 in the Line of Sines, to 22 deg. 53 min. in the Line of *Tangents*.

Prob.

Probleme 3.

The *Legg* given, to find an *Angle*.

In the *Right Angled Spherical Triangle* A B C, the *Angle Comp.* A, are of the *Extreams Conjunct*, is inquired.

The given *Leggs*, { A B, 47 deg. the *Middle part*, B C, 22. 53. the other *Extream.*]

Termes of Proportion,

As the *Sine* of the *Leg* conterminate to the *Tangent* of the other *Leg*, so is *Radius* to the *Tangent* of the *Angle* inquired.

Illustration by Artificial Numbers.

As the *Sine* A B, 47 deg.	9, 8641275
To the *Tangent* B C 22 deg. 53 min.	9, 6253884
so is *Radius* 90 deg.	10,
	9, 6253884
to the *Tangent* of A 30 deg.	9, 7612609

By *Gunters* Ruler.

Extend the Compasses from 47 deg. in the Line of Sines, to 22 deg. 53 min. in the Line of Tangents; The same extent shall reach from 90 in the Line of Sines, to 30 in the Line of Tangents.

Probleme 4.

The *Hypothennse* and a *Leg* given, to find the *Angle* contained by them.

In the *Right-angled Spherical Triangle* A B C.

The *Angle Comp.* C, or *Middle Part* is inquired.

The given { *Hypothennse*, *Comp.* A C, 51d. 4′. *Leg* B C 22d. 53′. } the *Adjacent Extream.*

Terms of Proportion,

As the *Tangent* of the *Hypothenuse* is to *Radius*, so is the *Tangent* of the *Leg* given to the *Sine Comp.* of the *Angle* inquired.

Illustration by Artificial Numbers.

As the *Tangent* of A C, 51 deg. 04 min.	10, 092664
is to *Radius* 90,	10,
so is the *Tangent* of B C, 22 deg. 53 min.	9, 625388
	19, 625388
to the *Sine* of 19 deg. 56 min.	9, 532724

The Complement of which is the Measure of the *Angle* A C B, 71 deg. 4 min. inquired.

By *Gunters* Ruler.

Extend the Compasses from 51 deg. 04 min. upon the Line of *Tangents* (being read backwards) unto 90 in the Line of Sines; the same extent will reach from the Tangent of 22 deg. 53 min. (downwards) unto the Sine of 19 deg. 56 m. the Complement of the Angle at C.

Probleme 5.

A *Leg* and an *Angle* conterminate with it given, to find the *Hypothenuse*.

In the *Right-angled Spherical Triangle*, A B C, the *Hypothenuse*, *Comp.* A C, one of the *Extreams Conjunct* is inquired.

The given { *Leg* A B, 47 deg. } the other *Extream Conj.*
{ *Angle Comp.* C A B, 30 } the *Middle Part*.

Terms of Proportion.

As *Radius* to the *Tangent Comp.* of the *Leg* given, so the *Sine Comp.* of the *Leg* given to the *Sine* of the *Hypothenuse* inquired.

Illustra-

Illustration by Artificial Numbers.

As the *Radius* 90. 10,
to the *Tangent Comp.* of the *Leg* A B, 43 deg. 9, 969655
so is the *Sine Comp.* of the *Angle*, C A B, 60. 9, 937530
9, 907185

to the *Tangent Comp.* of the *Hypothenuse*, 38 deg. 55 min. the *Complement* of which is 51 deg. 05 min. the *Hypothenuse*, A C.

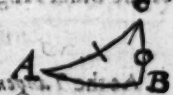
By *Gunters* Ruler.

Extend the Compasses from 90 in the Line of Sines, to 43 in the Line of *Tangents*, the same extent shall reach from 60 in the Line of Sines to 38 deg. 55 min. in the Line of *Tangents*, the Complement of which is 52 deg. 05 min. the *Hypothenuse* A C inquired.

Probleme 6.

The *Hypothenuse* and *Angle* given, to find the *Leg* conterminate with the given *Angle*.

In the *Right-angled Spherical Triangle*, A B C, the *Leg* B C, one of the *Extreams adjacent* is required.



The given { *Hypothenuse Comp.* A C, 51 d. 05 m. } other *Extream adjacent.*
{ *Angle Comp.* B C A, 70 deg. 04′. } the *Middle part.*

Terms of Proportion.

As the *Radius* to the *Tangent* of the *Hypothenuse*, so *Sine Complement* of the *Angle* given to the *Tangent* of the *Leg* inquired.

Illustration by Artificial Numbers.

As *Radius* 90, 10,
is to the *Tangent* of the *Hypothenuse* A C, 51 deg. 04 m. 10, 092813
so is the *Sine Comp.* of B C A 19 deg. 56 min. 9, 532753
to the *Tangent* of C B, 22 d. 53′ the *Leg* inquired. 9, 625566

By *Gunters* Ruler.

Extend the Compaſſes from 90 in the Line of Sines, unto 51 deg. 04 min. in the Line of Tangents, and the ſame extent ſhall reach from 19 deg. 56 min. in the Line of Sines unto 22 deg. 53 min. in the Line of Tangents, which is the Leg C B inquired.

Probleme 7.

The Oblique Angles given, to find the *Hypothenuſe*.

In the *Right-angled Spherical Triangle* A B C, the *Hypothenuſe* Comp. A C, the *Middle part* is inquired.

The given Angle { *Comp.* B A C, 30 d. } the *Extreams*,
{ *Com.* A C B, 70 d. 4′. } *Conjunct.*

Terms of Proportion.

As the *Tangent* of either Angle is to *Radius*, ſo is the *Tang. Compl.* of the other Angle to the *Sine Compl.* of the *Hypothenuſe*.

Illuſtration by Artificial Numbers.

As the *Tangent* of the Angle A C B, 70 d. 4′.	10, 440508
is to *Radius*,	10,
ſo is the *Tangent* of the Angle C A B, 60 d.	10, 238560
	20, 238560
to the *Sine* of 38 d. 55′. the *Comp.* of	9, 798052

which is the *Hypothenuſe* inquired A C 51 d. 05′.

By *Gunters* Ruler.

Extend the Compaſſes from 70 deg. 04 m. the *Tangent* of A B C, in the Line of *Tangents*, to the *Tangent* of 60, the Angle C A B; the ſame Extent ſhall reach from 90 in the Line of *Sines*, to 38 deg. 55 m. in the Line of *Sines*, the *Comp.* of which Angle found is 51 deg. 05 min. the *Hypothenuſe* A C, inquired.

Probleme 8.

The *Hypothenuſe* and an Angle given, to find the other Angle.

In the *Right-angled Spherical Triangle* A B C, the Angle *Comp.* C, one of the *Extreams Conjunct* is inquired.

The given Angles { *Hypothenuſe, Comp.* A C, 51 d. 5′. *Mid. part,* / Ang. *Com.* A C B, 70 d. 4′. the other *Extr. Conj.*

Terms of Proportion.

As the *Radius* to the *Tangent* of the Angle given, ſo is the *Sine Comp.* of the *Hypothenuſe*, to the *Tangent Compl.* of the Angle required.

Illuſtration by Artificial Numbers.

As the *Radius* 90,	10,
to the *Tangent* of the Angle A C B, 70 d. 4′.	10, 440403
ſo is the *Sine Compl.* of the *Hypothenuſe* A C, 38 d. 55′.	9, 798156
to *Tangent* 60,	10, 238559

The *Complement* of which is 30, the Angle C A B. inquired.

By *Gunters* Ruler.

Extend the Compaſſes from 90 in the Line of *Sines*, to 38 deg. 55′. in the Line of *Sines*; the ſame extent ſhall reach from 70 deg. 4 min. the *Tangent* of the Angle A C B, in the Line of *Tangents*, to 60 in the Line of *Tangents*, the *Complement* of which is 30, the Angle C A B, inquired.

Probleme 9.

The *Hypothenuſe* and an *Oblique Angle* given, to find the *Leg* oppoſite to the given *Angle*.

In the *Right-angled Spherical* Triangle A B C, the *Leg* B C, the *Middle part*, is inquired.

Terms

The given { *Hypothenuſe Compl.* A C. 51 d. 5, m. / Angle *Comp.* B A C, 30. } *Middle part*, The other *Extr. Conj.*

Terms of Proportion.

As the whole *Sine*, ſo *Sine* of the *Hypothenuſe*, to the *Sine* of the Angle given, to the *Sine* of the *Leg* inquired.

Illuſtration by Artificial Numbers.

As the whole *Sine* 90 deg.	10,
is to the *Sine* of the Angle C A B 30 deg.	9, 698970
ſo is the *Sine* of the *Hypothenuſe* 51 deg. 5'.	9, 891013
to the *Sine* of the *Leg* B C, 22 deg. 53'.	9, 589983

By *Gunters* Ruler.

Extend the Compaſſes from 90 in the Line of *Sines*, to the *Sine* of 30; the ſame Extent ſhall reach from the *Sine* of 51 deg. 5 min. unto the *Sine* of 22 deg. 53 min. the *Leg* B C.

Probleme 10.

A *Leg* and Angle oppoſite thereunto being given, to find the *Hypothenuſe*, if it be known whether it or the other *Leg* or Angle be *Acute* or *Obtuſe*.

In the *Right-angled Spherical Triangle* A B C, the *Hypothenuſe Comp.* A C, one of the *Extreams Disjunct* is inquired.

The given { Angle *Comp.* B A C, 30 deg. / *Leg* B C, 22 deg. 53 min. } the other *Extr. Disj.* / the *Middle part.*

Terms of Proportion.

As *Sine* of the *Oblique* Angle given,
to the whole *Sine*,
ſo the *Sine* of the *Leg* given,
to the *Sine* of the *Hypothenuſe* inquired.

Illuſtra-

Illustration by Artificial Numbers.

As the Sine of the Angle B A C, 30 deg.	9, 698970
to the whole Sine of A C, 90 deg.	10,
so is the Sine C B, 22 deg. 53. min.	9, 589788
	19, 589788
to the Sine of A C, 51 deg. 3′.	9, 890818

By *Gunters* Ruler.

Extend the Compasses from 30 deg. in the Line of *Sines*, unto 90; the Same extent shall reach from the *Sine* of 22 deg. 53 min. unto the *Sine* of 51 deg. 3 min. the *Hypothenuse* A C inquired.

Probleme II.

The *Hypothenuse* and a *Leg* given, to find the Angle opposite to the *Leg* given.

In the *Right-angled Spherical Triangle* A B C, the Angle *Comp.* A, one of the *Extreams Disjunct* is inquired.

The given { *Hypoth. Compl.* A C 51d, 5′. } the other *Extr. Disj.*
{ *Leg* B C, 22 deg. 53 min. } the *Middle part.*

Terms of Proportion.

As the *Sine* of the *Hypothenuse*, } So the whole *Sine*,
to the *Sine* of the *Leg* given, } to the *Sine* of the Angle inquired.

Illustration by Artificial Numbers.

As the *Sine* A C, 51 deg. 5 min.	9, 891013
to the *Sine* C B, 22 deg. 53. min.	9, 589788
so the whole *Sine* 90	10, 0.
	19, 589788
to the *Sine* C A B, 30 deg.	9, 698775

By *Gunters* Ruler.

Extend the Compasses from 51 deg. 5 min. to the *Sine* of 22 deg. 53 min.

53 min. the ſame Extent ſhall reach from the Sine of 90 unto the Sine of 30, the Sine of the Angle C A B.

Probleme 12.

An *Angle* and a *Leg* conterminate with it being given, to find the other *Angle*.

In the *Right-angled Spherical Triangle* A B C, the *Angle Comp.* B A C, the *Middle part* is inquired.

The given { *Angle* A C B, 70 deg. 04 m. } *Extreams*
{ *Leg.* B C, 22 deg. 53. min. } *Disjunct.*

Terms of Proportion,

As the whole *Sine* 90, } ſo the *Sine Comp.* of the given *Leg*,
to the *Sine* of the *Angle* given, } to the *Sin. Com.* of the *Ang.* inquired

Illuſtration by artificial Numbers.

As the whole *Sine* 90 deg.	10,
to the *Sine* of the *Angle* A C B, 70 deg. 04′.	9, 973169
ſo is the *Sine Comp.* of the *Leg* C B, 67 deg. 6′.	9, 964347
to the *Sine* 60 deg. the *Complement*	9, 937516

of which is 30 the meaſure of the *Angle* inquired.

Performed by Gunters *Ruler.*

Extend the Compaſſes from the Sine of 90, unto the Line of 70 deg. 4′ the ſame Extent ſhall reach from the Sine of 67d. 6′. to the Sine of 60. deg. the *Compl.* of which being 30, is the meaſure of the Angle C A B inquired.

Probleme 13.

An *Angle* and a *Leg* oppoſite thereunto being given, to find the other *Angle*; if it be known whether it, the *Hypothenuſe* or the other *Leg* be Acute or Obtuſe.

In

In the *Right-angled Spherical Triangle*, A B C, the *Angle Comp.* C B, one of the *Extreams Disjunct* required.

The given { *Leg* B C, 22 deg. 53 m. } *Extreams Disjunct.*
{ *Angle* B A C, 30 } *Middle Part.*

Terms of Proportion.

As the *Sine Comp.* of the *Leg* given,
to the *Sine Comp.* of the *Angle* given,
so is the *Radius*
to the *Sine* of the *Angle* inquired.

Illustration by Artificial Numbers.

As the Sine *Comp.* of the *Leg* given B C, 67 deg. 6′	9, 964347
is to the Sine *Compl.* of the Angle given, B A C, 60	9, 937530
so is the whole Sine 90,	10,
	19, 937530
to the Sine of 70 d. 4′ the Angle A C B, inquired.	9, 973193

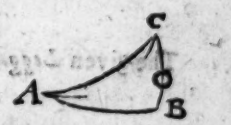
By *Gunters* Ruler.

Extend the Compasses from 67 deg. 6′. in the Line of *Sines*, unto the *Sine* of 60; the same extent shall reach from the *Sine* of 90 to the *Sine* of 70 deg. 4 min. the measure of the Angle A C B inquired.

Probleme 14.

The *Obique* Angle given, to find the other *Leg*.

In the *Right-angled Spherical Triangle* A B C, the *Leg* B C, one of the *Extreams Disjunct* is inquired.



The given { *Compl.* A C B 70d. 6'. } the other *Extr. Disj.*
{ *Comp.* C A B, 30 deg. 00 m. } the *Middle part.*

Terms of Proportion.

As the *Sine* of the Angle conterminate with the *Leg* inquired,
to the *Sine Complement* of the Angle oppofite to the *Leg* inquired.
ſo the whole *Sine*,
to the *Sine Compl.* of the *Leg* inquired.

Illuſtration by Artificial Numbers.

As the *Sine* of the Angle A C B, 70 deg. 4 min. 9, 973169
to the *Sine Comp.* of the Angle C A B, 60 deg. 9, 937530
ſo is the whole *Sine* 90 deg. 10,
19, 937530
to the *Sine* of 67 deg. 6'. 9, 964361
the *Complement* of which is 22 deg. 54'. the *Leg* B C, inquired.

By *Gunters* Ruler.

Extend the Compaſſes from 70 deg. 4 min. in the Line of Sines, unto 60 in the ſame Line, the ſame extent ſhall reach from the *Sine* of 90 to the *Sine* of 67 deg. 6'. the *Complement* of which is 22 deg. 54 min. the Side B C, inquired.

Probleme IX.

The *Leg* given, to find the *Hypothenuſe*.

In the *Right-angled Spherical Triangle* A B C, the *Hypothenuſe Comp.* A C, the *Middle part* is inquired.

The given *Leggs* { A B, 49 deg. 00. } *Extreme.*
{ A C, 70 deg. 4 m. } *Conjunct.*

Terms of Proportion.

As the whole *Sine*

to the *Sine Compl.* of one *Leg*:
so the *Sine Comp.* of the other *Leg*,
to the *Sine Comp.* of the *Hypothenuse*.

Illustration by Artificial Numbers.

As the whole *Sine* of 90 — 10,
is to the *Sine Comp.* of the *Leg* A B, 43 deg. — 9, 833783
so is the *Sine Comp.* of the other *Leg* B C, 67 d. 6′. — 9, 964347
to the *Sine* 38 deg. 55′. — 9, 798564
the *Complement* of which Angle is 51 deg. 05 min.
the *Hypothenuse* inquired.

By *Gunters* Ruler.

Extend the Compasses from 90 in the Line of Sines, to the *Sine* of 43 d. the same extent shall reach from the Sine of 67 d. 6 m. to the Sine of 38 deg. 55 min. the Complement of which is 51 deg. 05 min. the Side A C, the *Hypothenuse* inquired.

Probleme 16.

The *Hypothenuse* and a *Leg* given, to find the other *Leg*.

In the *Right-angled Spherical Triangle*, A B C, the *Leg* A B, one of the *Extreams Disjunct* is required.

The given { *Leg* B C, 22 deg. 54 min. } other *Extream Disj.*
{ *Hypothenuse*, A C, 51 d. 5′. } the *Middle part*.

Terms of Proportion.

As the *Sine Comp.* of the *Leg* given,
to the whole *Sine*:
so is the *Sine Complement* of the *Hypothenuse*,
to the *Sine Comp.* of the *Leg* inquired.

Illustration by Artificial Numbers.

As the Sine *Comp.* of the *Leg* given, B C, 67 d. 6 d.	9, 964347
to the whole *Sine* 90.	10,
so is the *Sine Comp.* of *Hypothenuse*, 38 deg. 55 min.	9, 798090
	19, 798090
to the *Sine* of 43 deg.	9, 833743

the *Comp.* of which Angle found is 47, the measure of the *Leg* A B inquired.

By *Gunters* Ruler.

Extend the Compasses from 67 deg. 06 min. in the Line of *Sines*, unto the Sine of 90; the same extent shall reach from 38 deg. 55 m. to the Sine of 43 deg. the *Sine* Complement, of which is the Side A B, required.

Of Oblique Angled Spherical Triangles.

CHAP. VIII.

Of the Calculation of Oblique Spherical Triangles.

IN *Oblique Angled Spherical Triangles* there are 12 Cases, 10 whereof may be resolved by the *Catholick Proposition*. If the *Oblique Spherical Triangle* propounded, be first converted into two right, by leting fall a *Perpendicular*, sometimes within, and sometimes without the *Triangle*. If the Angles at the *Base* be both Acute, or both Obtuse, it falleth within the *Triangle*; but if one of the Angles at the *Base* be Acute, and the other Obtuse, it falleth without; however it falleth, it must alwayes be oppofite to a known Angle, according to this general direction.

From the end of a *Side* given, being adjacent to an *Angle* given, let fall the *Perpendicular*.

As in the following *Triangle* A B C, if there were given the *Side* A B, and the Angle at A, by this Rule the *Perpendicular* must fall from B upon the *Side* A C.

But if there were given the Side A C, and the *Angle* at A, the *Perpendicular* must fall from C upon the *Side* A B, continued if need requite.

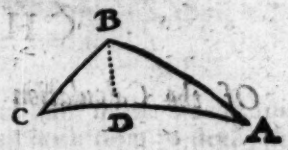
And to know whether the Side upon which the *Perpendicular* shall fall, must be continued or not; that is, to know whether the *Perpendicular* shall fall within or without the *Triangle*, if the former direction be not sufficient, the Calculation will determine it. For if the Arch found at the first operation (whether *Side* or *Angle*) be more than the

the Arch given, the *Perpendicular* ſhall fall without, if leſs, then within the *Triangle*, as may plainly appear in the Explanation of theſe enſuing *Problems*.

Probleme I.

Two *Sides* with an Angle oppoſite to one of them being given, to find the Angle oppoſite to the other; if it be known, whether the Angle ſought be *Acute* or *Obtuſe*.

In the *Oblique Spherical Triangle* A B C, the Angle B A C is required.



The given { Sides { A B, 42 d. 9 m. / B C, 29 d. 50 m. / Angle A C B, 36 deg. 8 min.

Terms of Proportion.

As the *Sine* of the Angle oppoſite to the *Side* given,
to the *Sine* of the given *Side*;
ſo the *Sine* of the other Angle
to the *Sine* of the *Side* inquired.

Illuſtrations by Artificial Numbers.

As the *Sine* of A B 42 deg. 09 min.	9, 826770
to the *Sine* of B C, 29 deg. 50. min.	9, 696730
ſo is the *Sine* of A C B, 36 deg. 8 min.	9, 770675
	29, 467405
to the *Sine* of B A C, 25 deg. 55′.	9, 640635

By *Gunters* Ruler.

Extend the Compaſſes from 42 d. 9′. in the Line of *Sines*, unto the *Sine* of 29 deg. 50′. the ſame Extent ſhall reach from 36 deg. 8 min. to 25 deg. 55′. the *Sine* of B A C, inquired.

Prob.

Probleme 2.

Two *Angles* with a *Side* oppoſite to one of them being given, to find the *Side* oppoſite to the other; if it be known whether the *Side* ſought be more or leſs than a *Quadrant*.

In the foregoing *Oblique Angled Spherical Triangle* A B C, the *Side* A B is inquired.

The given { *Angles* { B A C, 25d 55′. / A C B, 36, 8. / *Side* B C, 29 50.

Terms of Proportion,

As the *Sine* of the Angle oppoſite to the Side given, to the *Sine* of given *Side*, ſo the *Sine* of the other *Angle* to the *Sine* of the *Side* inquired.

Illuſtration by Numbers.

As the *Sine* of the Angle given, B A C, 25 d. 55 m.	9, 640544
is to the *Sine* of the other Angle given A C B, 36 d. 8′.	9, 770675
ſo is the *Sine* of the *Side* given B C, 29 deg. 50 min.	9, 696730
	19, 467405
to the *Sine* of *Side* A B, 42 deg. 9 min.	9, 826861

By *Gunters* Ruler.

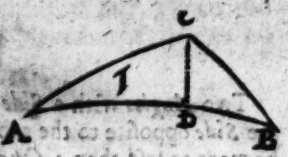
Extend the Compaſſes from 25 deg. 55 min. in the Line of *Sines*, to the *Sine* of 36 deg. 8′; the ſame Extent will reach from the *Sine* 29 deg. 50 min. unto the *Sine* of 42 deg. 09′, the meaſure of the Side inquired. A B 42 deg. 9 min.

Probleme 3.

Two Sides and their contained Angle given to find the third Side.

In

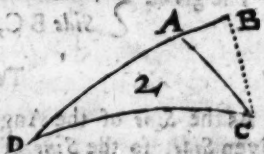
In the *Oblique Spherical Triangle* A C D, the Side D C is inquired.



Upper *Scheme.*

The given { *Sides* { A D 42 deg. 9 min. / A C 30 deg. 00′. / *Angle* D A C, 36 deg. 07 m.

Lower *Scheme.*



The given { *Sides* { A D, 24 deg. 3 min. / A C 30, / *Angles* D A C, 103 deg. 59 min.

This *Probleme* doth require a double operation; the first serves for finding the *Segments* of the *Base* or *Vertical Angles*; the other for the *Angles* or *Sides* inquired.

Terms of Proportions,

1. For the *Segment* of the *Base*.

As *Radius*
to the *Tangent* of the *Hypothenuse*,
so is *Sine Compl.* of the *Angle* comprehended,
to the of *Tangent* the *Segment* of the *Base Conterm.* with the *Angle* comprehended.

2. For the *Side* inquired.

As the *Co-Sine* of the first *Base*
to the *Co-Sine* of the *Hypothenuse*,
so is the *Co-Sine* of the second *Base*
to the *Co-Sine* of the *Side* inquired.

1. Opera-

1. Operation.

Illustration by Numbers.

As *Radius* 90,	10,
is to the *Tangent* of A C 30 deg.	9, 76143
so is the *Co-Sine* of the Angle D A C 53 d. 52′.	9, 90722
to *Tangent* of the *Segm. Base* B D, 25 deg.	9, 66865
whose *Complement* is A B, 65 deg.	

By *Gunters* Ruler.

Extend the Compasses from 90 in the Line of *Sines*, to 30 in the Line of *Tangents*, the same extent shall reach from 53 deg. 52 min. in the Line of *Sines*; the other foot will fall upon 25 deg. in the Line of *Tangents*, the *Complement* of which is 65 deg. the quantity of the *Side* A B in the Upper *Triangle*.

2. Operation.

Illustration by Numbers.

As the *Co-Sine* of A B, 25 d. 00′.	9, 95727
to the *Co-Sine* of A C, 60 deg. 00′.	9, 93753
so is the *Co-Sine* of D B, 27 d. 51′.	9, 98025
	19, 91778
to the *Co-Sine* of D C, 65 d. 56′.	9, 96051

Therefore D C 24 deg. 4 min.

Probleme 4.

Two *Sides* with the *Angle* opposite to one of them, to find the third *Side*: if it be known, whether the *Side* sought, or the *Angle* opposite, or the other given *Side*, be *Acute* or *Obtuse*.

In the *Oblique-angled Spherical Triangle* A C D, the *Side* A D is inquired.

1. *Super Scheam.*

The given { *Sides* { A C 24 d. / D C 30 d. } / *Angle* A D C.

In this Case let the *Perpendicular* fall from the Concourse of the given *Sides*; on the *Side* inquired.

The terms of Proportion abreviated.

1 ct CD. R :: cs. ADC. t. BD
2 cs BD. cs CD :: R. cs. CB.
3 cs CB. R :: cs AC. cs AB.

Therefore,

cs CD. cs BD :: cs AC. cs AB
and BD + AB = AD in the 1 *Triangle.*
But BD — AB = AD in the 2 *Triangle.*

Probleme 5.

Two *Sides* and their contained *Angle* given, to find one of the other *Angles.*

In the *Oblique Spherical Triangle* aforegoing A C D, the *Angle* A D C is inquired.

The given { *Sides* { A C, A D
Angle C A D

In this Case the *Perpendicular* may fall from the *Extremity* of either *Side* given, oppoſite to the *Angle* given.

Terms of Proportion.

1 ct AC, R :: cs DAC. t AB
and AD — AB = BD in the 1 *Triangle.*
But AD + AB = BD in the 2 *Triangle.*
ct CAD. s AB :: R. t BC
t BC. R :: s BD ct ADC

Therefore:

s AB. ct CAD. 2 s BD ct ADC.

Probleme 6.

Two *Angles*, and a *Side* oppoſite to one of them, being given, to find the ſide between them: if it be known whether the *Side* ſought, or the *Side* oppoſite to the other given *Angle*, be *Obtuſe* or *Acute.*

In

In the *Oblique-angled Spherical Triangle* A C D, before-going, the *Side* A D is inquired.

The given { *Angles* { A D C / C A D ; *Side* A C }

In this Case let the *Perpendicular* fall from the *Extremity* of the given *Side*, on the *Side* inquired; continued if need be.

Termes of Proportion.

1 ct AC. R :: cs DAC t AB.
2 ct CAD. s AB :: R t BC
3 R t BC :: ct ADC s BD.

Therefore,

ct CAD. s AB :: ct ADC s BD
and AB + BD = AD in the 1 *Triangle.*
But DB — AB = AD in the 2 *Triangle.*

Probleme 7.

Two *Angles*, and a *Side* opposite to one of them, being given, to find the third *Angle*: if it be known, whether the Angle inquired, or the *Side* opposite to the other given *Angle*, be *Acute* or *Obtuse*.

In the *Oblique-angled Spherical Triangle* A C D before going, the *Angle* A C D is inquired.

The given { *Angles* { D A C / A D C ; *Side* A C }

In this case let the *Perpendicular* fall from the *Angle* inquired.

The terms of Proportion.

1 ct CAD. R :: cs AC. ct ACB.
2 s ACB. cs CAB :: R cs BC
3 cs BCR :: cs BDC

Therefore,

cs CAB. s ACB :: cs BDC. s BCD.
and ACB + BCD = ACD in the fifft *Triangle.*
But BCD — ABC = ACD in the ſecond *Triangle.*

Probleme 8.

Two *Angles*, and the *Side* between them, being given, to find the third *Angle.*

In the *Oblique Spherical Triangle* ACD before-going, the *Angle* ADC is inquired.

The given { *Angle* { ACD, CAD; *Side* AC }

In this Caſe let the *Perpendicular* fall from the *Extremity* of the given *Side*, and oppoſite to the *Angle* inquired.

The terms of Proportion.

r ct CAB. R :: cs AC. ct ACB.
and ACD — ACB = BCD in the firſt *Triangle.*
But ACD + ACB = BCD in the ſecond *Triangle.*
2 s ACB. cs CAB :: R. cs BC
3 R. cs BC :: s BCD. cs CDB.

Therefore,

s ACB. cs CAB :: s BCD. cs CDB

Probleme 9.

Two *Sides*, with an *Angle* oppoſite to one of them, being given; to find their contained *Angle*: if it be known, whether the Angle inquired, or the Angle oppoſite to the other given, *Side* be *Acute* or *Obtuſe.*

In the *Oblique-angled Spherical Triangle* ACD afore-going, the Angle ACD is inquired.

The given { *Sides* { AC, CD; *Angle* ADC }

In

In this Case let the *Perpendicular* fall from the *Angle* inquired.

The terms of Proportion.

1 ct CDB. R :: cs CD. ct BCD
2 ct CD. cs BCD :: R. t BC
3 R. t BC :: ct AC. cs ACB

Therefore,

ct CD. cs BCD :: ct AC. cs ACB
and BCD + ACB = ACD in the first *Triangle*.
But BCD — ACB = ACD in the second *Triangle*.

Probleme. 10.

Two *Angles* and the *Side* between them given, to find either of the other *Sides*.

In the *Oblique Spherical Triangle* A C D afore-going, the *Side* D C is inquired.

The given { *Angles* { D A C, A C D; *Side* A C }

In this Case let the *Perpendicular* fall from the Concourse of the *Side* given, and sought on the third *Side*, continued if need be.

The terms of Proportion.

1 ct CAB. R :: cs AC. ct ACB
and ACD — ACB = BCD in the first *Triangle*.
But ACD + ACB = BCD in the second *Triangle*.
2 ct AC. cs ACB :: R. t BC
3 t BC. R :: cs BCD. ct CD.

Therefore,

cs BCA. ct AC :: cs BCD. ct CD.

Probleme 11.

Three *Sides* being given, to find an *Angle*.

In

In the *Oblique Spherical Triangle* following A B C, the *Angle* B A C is inquired.

The given { *Sides* { A B, B C; *Base* A C }

In the solution of this *Probleme*, this preparation is to be made to make it conformable to the *Catholick Proposition*, which first findeth the difference of the Segments of that Side; which being made, the *Base* of the *Triangle* is divided into two parts, by letting fall a *Perpendicular*, and that by help of this *Analogie*. Demonstrated by the learned Mr. *J. N.* in the 2d Book of *Trig. Brit. Cap.* 2.

As the *Tangent* of half the *Base*
is to the *Tangent* of half the sum of the other *Sides*,
so is the *Tangent* of half the diff. of those *Sides*,
to the *Tangent* of half the diff. of the *Segments* of the *Base*.

Then the terms of Proportion.

t ½ A C. t ½ Z cru. A B. B C :: t ½ X cru. t ½ A E

and { ½ A C + ½ A E = A D
½ A C — ½ A E = D C in the 1st *Triangle*.

{ ½ A E + ½ A C = A B
½ A E — ½ A C = B E, or B C in the 2d *Triangle*.

From hence to find the *Angle* at A,
R. c t A B :: t A D. c s B A D

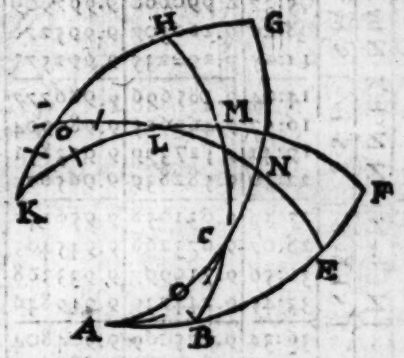
Probleme 12.

The three *Angles* given, to find a *Side*.

This *Probleme* is the Converse of the last afore-going, and to be resolved after the same manner, if so be the *Angles* are converted into *Sides*; for the two less *Angles* are alwayes equal unto two *Sides* of a *Triangle*, comprehended by the Arches of great Circles drawn from their

their *Poles*; and the Complement of the greateſt *Angle* to a *Semicircle* muſt be taken for the third *Side*. If therefore by the precedent *Problems* you find an *Angle*, that *Angle* ſo found ſhall be one of the three *Sides* inquired.

As in the *Triangle* A B C (in the following figure) the *Poles* of thoſe *Arches* are L I K, which connected, make the *Triangle* L I K, the *Sides* of the former *Triangle*, being equal to the *Angles* of the latter; taking for one of them the Complement of the greater *Angle* to a *Semicircle*, as A B is equal to the *Angle* at L, or the *Arch* E F B C is equal to the *Angle* at K, or the *Arch* M H.



And A C is equal to the Complement of the *Angle* L I K or the *Arch* N G.

Therefore if the *Angles* A B C be given, the *Sides* K I, K L, I L, are likewiſe given.

If therefore the *Triangle* L I K be reſolved by the Directions of the laſt *Problems*, the *Angle* ſo found ſhall be the *Side* inquired.

A Table

A Table of Sines and Tangents for every Point, half Point and quarter Point of the Compass.

N	S.	D. M.	Sine	Sin. Com.	Tangent	Tang. Com.	S.	N
		02:49	8.691437	9.999475	8.691962	11.308037		
	N by E	05:37	8.990660	9.997909	8.992750	11.007249	S by W	N by W
		08:26	9.166307	9.995278	9.171028	10.828971		
1		11:15	9.290235	9.991573	9.298661	10.701338		1
		14:04	9.385696	9.986277	9.398919	10.601080		
	N N E	16:52	9.462615	9.980904	9.481711	10.618288	S S W	N N W
		19:41	9.527399	9.973851	9.553547	10.446452		
2		22:30	9.582839	9.965615	9.617224	10.382775		2
		25:19	9.631058	9.956148	9.674910	10.325089		
	N E by N	28:07	9.673268	9.945463	9.727804	10.272195	S W by S	N W by N
		30:56	9.710997	9.933368	9.777628	10.222371		
3		33:45	9.744739	9.919846	9.824892	10.175107		3
		36:34	9.775069	9.904804	9.870265	10.129734		
	N E	39:22	9.802281	9.888237	9.914044	10.085655	S W	N W
		42:11	9.827049	9.869818	9.957231	10.042768		
4		45:00	9.849485	9.849485	10.000000	10.000000		4
		47:49	9.869818	9.827049	10.042768	9.957231		
	N E by E	50:37	9.888133	9.802435	10.085698	9.914302	S W by W	N W by W
		53:26	9.904804	9.775069	10.129734	9.870265		
5		56:15	9.919846	9.744739	10.175107	9.824892		5
		59 04	9.933368	9.710997	10.222371	9.777628		
	E N E	61:52	9.945396	9.673504	10.271891	9.728108	W S W	W N W
		64:41	9.956148	9.631058	10.325089	9.674910		
6		67:30	9.965615	9.582839	10.382775	9.617224		6
		70:19	9.973851	9.527399	10.446452	9.553547		
	E by N	73:07	9.980865	9.463032	10.517833	9.482166	W by S	W by N
		75 56	9.986777	9.385696	10.601080	9 398919		
7		78:45	9 991573	9.290235	10.701338	9 298661		7
		81:34	9.995278	9.166307	10.828971	9.171028		
	East	84:22	9.997897	8.991942	11.005954	9.994045	West	West
8	East	87:11	9.999475	8.691437	11.308037	8.691962		8
		90:00		10.00000		Infinite.		

Nū.	Logarithm.	Nū.	Logarithm.	Nū.	Logarithm.	Nū.	Logarithm.
1	0.0000000	36	1.5563025	71	1.8512583	106	2,0253058
2	0.3010300	37	1.5682017	72	1.8573325	107	2,0293838
3	0.4771212	38	1.5797836	73	1.8633228	108	2,0334237
4	0.6020600	39	1.5910646	74	1.8692317	109	2,0374265
5	0.6989700	40	1.6020600	75	1.8750612	110	2,0413927
6	0.7781512	41	1.6127838	76	1.8808136	111	2,0453230
7	0.8450980	42	1.6232493	77	1.8864907	112	2,0492180
8	0.9030900	43	1.6334684	78	1.8920946	113	2,0530784
9	0.9542425	44	1.6434527	79	1.8976271	114	2,0569048
10	1.0000000	45	1.6532125	80	1.9030900	115	2,0606978
11	1.0413927	46	1,6627578	81	1.9084850	116	2,0644580
12	1.0791812	47	1.6720978	82	1.9138138	117	2,0681858
13	1.1139433	48	1.6812412	83	1.9190781	118	2,0718820
14	1.1461280	49	1.6901961	84	1.9242793	119	2,0755469
15	1.1760912	50	1.6989700	85	1.9294189	120	2,0791812
16	1.2041200	51	1.7075702	86	1,9344984	121	2,0827854
17	1.2304489	52	1.7160033	87	1.9395192	122	2,0863598
18	1.2552725	53	1.7242759	88	1.9444827	123	2,0899051
19	1.2787536	54	1.7323937	89	1.9493900	124	2,0934217
20	1.2010300	55	1.7403627	90	1.9542425	125	2,0969100
21	1.3222193	56	1.7481880	91	1.9590414	126	2,1003705
22	1.3424227	57	1.7558748	92	1.9637878	127	2,1038037
23	1.3617278	58	1.7634280	93	1.9684829	128	2,1071099
24	1.3802112	59	1.7708520	94	1.9731278	129	2,1105897
25	1.3979400	60	1.7781512	95	1.9777236	130	2,1139433
26	1.4149733	61	1.7853298	96	1.9822712	131	2,1172713
27	1.4313637	62	1.7923917	97	1.9867717	132	2,1205739
28	1.4471580	63	1.7993405	98	1.2912261	133	2,1238516
29	1.4623980	64	1.8061800	99	1.9956352	134	2,1271048
30	1.4771212	65	1.8129133	100	2.0000000	135	2,1303337
31	1.4913617	66	1.8195439	101	2.0043214	136	2,13353 89
32	1.5051500	67	1.8260748	102	2.0086002	137	2,1367205
33	1.5185139	68	1.8325089	103	2.0128372	138	2,1398791
34	1.5314789	69	1.8388491	104	2,0170333	139	2,1430148
35	1.3440680	70	1.8450980	105	2.0211893	140	2,1461280

Nu.	Logarithm.	Nu.	Logarithm.	Nu.	Logarithm.	Nu.	Logarithm.
141	2,1492191	176	2,2455126	211	2,3242824	246	2,3909351
142	2,1522883	177	2,2479732	212	2,3263358	247	2,3926969
143	2,1553360	178	2,2504200	213	2,3283796	248	2,3944517
144	2,1583625	179	2,2528530	214	2,3304138	246	2,3961993
145	2,1613680	180	2,2552725	215	2,3324384	250	2,3979400
146	2,1643528	181	2,2576786	216	2,3344537	251	2,3996737
147	2,1673173	182	2,2600714	217	2,3364597	252	2,4014005
148	2,1702617	183	2,2624511	218	2,3384565	253	2,4031205
149	2,1731862	184	2,2648178	219	2,3404441	254	2,4048337
150	2,1760912	185	2,2671717	220	2,3424226	255	2,4065402
151	2,1789769	186	2,2695129	221	2,3443923	256	2,4082399
152	2,1818436	187	2,2718416	222	2,3463530	257	2,4099331
153	2,1846914	188	2,2741578	223	2,3483048	258	2,4116197
154	2,1875207	189	2,2764618	224	2,3502480	259	2,4132997
155	2,1903317	190	2,2787536	225	2,3521825	260	2,4149733
156	2,1931246	191	2,2810333	226	2,3541084	261	2,4166405
157	2,1958996	192	2,2833012	227	2,3560258	262	2,4183013
158	2,1986571	193	2,2855573	228	2,3579348	263	2,4199557
159	2,2013971	194	2,2878017	229	2,3598355	264	2,4216039
160	2,2041200	195	2,2900346	230	2,3617278	265	2,4232459
161	2,2068258	196	2,2922561	231	2,3636120	266	2,4248816
162	2,2095150	197	2,2944662	232	2,3654880	267	2,4265112
163	2,2121876	198	2,2966652	233	2,3673559	268	2,4281348
164	2,2148438	199	2,2988531	234	2,3692158	269	2,4297523
165	2,2174839	200	2,3010300	235	2,3710678	270	2,4313637
166	2,2201081	201	2,3031920	236	2,3729120	271	2,4329693
167	2,2227164	202	2,3053513	237	2,3747483	272	2,4345689
168	2,2253093	203	2,3074960	238	2,3765770	273	2,4361626
169	2,2278867	204	2,3096301	239	2,3783979	274	2,4377505
170	2,2304489	205	2,3117538	240	2,3802112	275	2,4393327
171	2,2329961	206	2,3138672	241	2,3820170	276	2,4409091
172	2,2355284	207	2,3159703	242	2,3838153	277	2,4424797
173	2,2380461	208	2,3180633	243	2,3856063	278	2,4440448
174	2,2405492	209	2,3201463	244	2,3873898	279	2,4456042
175	2,2430380	210	2,3222193	245	2,3891660	280	2,4471580

Lat.	Merid parts.	Lat.	Merid parts.	Lat.	Merid parts.
0 00	00	d m	00	d m	00
5	5	3 5	185	6 5	365
10	10	10	190	10	370
15	15	15	195	15	375
20	20	20	200	20	380
25	25	25	205	25	385
30	30	30	210	30	390
35	35	35	215	35	395
40	40	40	220	40	400
45	45	45	225	45	405
50	50	50	230	50	410
55	55	55	235	55	415
1 00	60	4 00	240	7 00	421
5	65	5	245	5	426
10	70	10	250	10	431
15	75	15	255	15	436
20	80	20	260	20	441
25	85	25	265	25	446
30	90	30	270	30	451
35	95	35	275	35	456
40	100	40	280	40	461
45	105	45	285	45	466
50	110	50	290	50	471
55	115	55	295	55	476
2 00	120	5 00	300	8 00	481
5	125	5	305	5	486
10	130	10	310	10	491
15	135	15	315	15	496
20	140	20	320	20	501
25	145	25	325	25	506
30	150	30	330	30	511
35	155	35	335	35	516
40	160	40	340	40	521
45	165	45	345	45	527
50	170	50	350	50	532
55	175	55	355	55	537
3 00	180	6 00	360	9 00	542

Lat.		Merid parts.	Lat.		Merid parts.	Lat.		Merid parts.
d	m		d	m		d	m	
9	5	547	12	5	730	15	5	915
	10	552		10	735		10	920
	15	557		15	740		15	925
	20	562		20	745		20	931
	25	567		25	750		25	936
	30	572		30	755		30	941
	35	577		35	761		35	946
	40	582		40	766		40	951
	45	587		45	771		45	957
	50	592		50	776		50	962
	55	597		55	781		55	967
10	00	603	13	00	786	16	00	972
	5	608		5	791		5	977
	10	613		10	797		10	983
	15	618		15	802		15	988
	20	623		20	807		20	993
	25	628		25	812		25	998
	30	633		30	817		30	1004
	35	638		35	822		35	1009
	40	643		40	827		40	1014
	45	648		45	833		45	1019
	50	653		50	838		50	1024
	55	658		55	843		55	1030
11	00	664	14	00	848	17	00	1035
	5	669		5	853		5	1040
	10	674		10	858		10	1045
	15	679		15	863		15	1050
	20	684		20	869		20	1056
	25	689		25	874		25	1061
	30	694		30	879		30	1066
	35	699		35	884		35	1071
	40	704		40	889		40	1077
	45	709		45	894		45	1082
	50	715		50	900		50	1087
	55	720		55	905		55	1093
12	00	725	15	00	910	18	00	1098

Lat.		Merid parts.	Lat.		Merid parts.	Lat.		Merid parts.
d	m		d	m		d	m	
18	5	1103	21	5	1294	24	5	1489
	10	1108		10	1299		10	1499
	15	1113		15	1305		15	1509
	20	1119		20	1310		20	1505
	25	1124		25	1316		25	1511
	30	1129		30	1321		30	1516
	35	1135		35	1326		35	1522
	40	1140		40	1332		40	1527
	45	1145		45	1337		45	1533
	50	1150		50	1342		50	1538
	55	1156		55	1348		55	1544
19	00	1161	22	00	1353	25	00	1549
	5	1166		5	1359		5	1555
	10	1172		10	1364		10	1561
	15	1177		15	1369		15	1566
	20	1182		20	1375		20	1572
	25	1187		25	1380		25	1577
	30	1193		30	1386		30	1583
	35	1198		35	1391		35	1588
	40	1203		40	1396		40	1594
	45	1209		45	1402		45	1599
	50	1214		50	1407		50	1605
	55	1219		55	1413		55	1610
20	00	1225	23	00	1418	26	00	1616
	5	1230		5	1424		5	1622
	10	1235		10	1429		10	1627
	15	1241		15	1434		15	1633
	20	1246		20	1440		20	1638
	25	1251		25	1445		25	1644
	30	1257		30	1451		30	1649
	35	1262		35	1456		35	1655
	40	1267		40	1462		40	1661
	45	1273		45	1467		45	1666
	50	1278		50	1473		50	1672
	55	1283		55	1478		55	1677
21	00	1289	24	00	1484	27	00	1683

Lat.		Merid parts.	Lat.		Merid parts.	Lat.		Merid parts.
d	m		d	m		d	m	
27	5	1689	30	5	1894	33	5	2105
	10	1694		10	1899		10	2111
	15	1700		15	1905		15	2117
	20	1705		20	1911		20	2123
	25	1711		25	1917		25	2129
	30	1717		30	1923		30	2135
	35	1722		35	1928		35	2141
	40	1728		40	1934		40	2147
	45	1733		45	1940		45	2153
	50	1738		50	1946		50	2159
	55	1744		55	1952		55	2165
28	00	1751	31	00	1958	34	00	2171
	5	1756		5	1963		5	2177
	10	1762		10	1969		10	2183
	15	1768		15	1975		15	2189
	20	1773		20	1981		20	2195
	25	1779		25	1987		25	2201
	30	1785		30	1993		30	2207
	35	1790		35	1998		35	2213
	40	1796		40	2004		40	2219
	45	1802		45	2010		45	2226
	50	1808		50	2016		50	2231
	55	1813		55	2022		55	2238
29	00	1819	32	00	2028	35	00	2244
	5	1825		5	2034		5	2250
	10	1830		10	2040		10	2256
	15	1836		15	2046		15	2262
	20	1842		20	2052		20	2268
	25	1848		25	2057		25	2274
	30	1853		30	2063		30	2281
	35	1859		35	2069		35	2287
	40	1865		40	2075		40	2293
	45	1871		45	2081		45	2299
	50	1867		50	2087		50	2305
	55	1882		55	2093		55	2311
30	00	1888	33	00	2099	36	00	2318

Lat.		Merid parts.	Lat.		Merid parts.	Lat.		Merid
d	m		d	m		d	m	
36	5	2324	39	5	2551	42	5	2788
	10	2330		10	2557		10	2795
	15	2336		15	2564		15	2802
	20	2342		20	2570		20	2808
	25	2349		25	2577		25	2815
	30	2355		30	2583		30	2822
	35	2361		35	2590		35	2829
	40	2367		40	2596		40	2835
	45	2373		45	2603		45	2842
	50	2380		50	2609		50	2849
	55	2386		55	2616		55	2856
37	00	2392	40	00	2622	43	00	2863
	5	2398		5	2629		5	2870
	10	2405		10	2635		10	2876
	15	2411		15	2642		15	2883
	20	2417		20	2648		20	2890
	25	2424		25	2655		25	2897
	30	2430		30	2662		30	2904
	35	2436		35	2668		35	2911
	40	2442		40	2675		40	2918
	45	2449		45	2681		45	2925
	50	2455		50	2688		50	2932
	55	2461		55	2695		55	2938
38	00	2468	41	00	2701	44	00	2945
	5	2474		5	2708		5	2952
	10	2481		10	2714		10	2959
	15	2487		15	2721		15	2966
	20	2493		20	2728		20	2973
	25	2500		25	2734		25	2980
	30	2506		30	2741		30	2987
	35	2512		35	2748		35	2994
	40	2519		40	2754		40	3001
	45	2525		45	2761		45	3008
	50	2532		50	2768		50	3015
	55	2538		55	2775		55	3022
39	00	2544	42	00	2781	45	00	3030

Lat.		Merid parts.	Lat.		Merid parts.	Lat.		Merid parts.
d	m		d	m		d	m	
45	5	3037	48	5	3299	51	5	3576
	10	3044		10	3306		10	3584
	15	3051		15	3314		15	3592
	20	3058		20	3321		20	3600
	25	3065		25	3329		25	3608
	30	3072		30	3336		30	3616
	35	3079		35	3344		35	3624
	40	3086		40	3351		40	3632
	45	3094		45	3359		45	3641
	50	3101		50	3366		50	3649
	55	3108		55	3374		55	3657
46	00	3115	49	00	3382	52	00	3665
	5	3122		5	3389		5	3673
	10	3130		10	3397		10	3681
	15	3137		15	3405		15	3689
	20	3144		20	3412		20	3697
	25	3151		25	3420		25	3706
	30	3159		30	3428		30	3714
	35	3166		35	3435		35	3722
	40	3173		40	3443		40	3730
	45	3180		45	3451		45	3739
	50	3188		50	3459		50	3747
	55	3195		55	3466		55	3755
47	00	3202	50	00	3474	53	00	3763
	5	3210		5	3482		5	3772
	10	3217		10	3490		10	3780
	15	3224		15	3498		15	3788
	20	3232		20	3505		20	3797
	25	3239		25	3513		25	3805
	30	3247		30	3521		30	3814
	35	3254		35	3529		35	3822
	40	3261		40	3537		40	3830
	45	3269		45	3545		45	3839
	50	3276		50	3553		50	3847
	55	3284		55	3561		55	3856
48	00	3291	51	00	3568	54	00	3864

Lat.		Merid parts.	Lat.		Merid parts.	Lat.		Merid parts.
d	m		d	m		d	m	
54	5	3873	57	5	4192	60	5	4537
	10	3881		10	4201		10	4547
	15	3890		15	4210		15	4557
	20	3899		20	4219		20	4567
	25	3907		25	4229		25	4578
	30	3916		30	4238		30	4588
	35	3924		35	4247		35	4598
	40	3933		40	4257		40	4608
	45	3942		45	4266		45	4618
	50	3950		50	4275		50	4629
	55	3959		55	4285		55	4638
55	00	3968	58	00	4294	61	00	4648
	5	3976		5	4304		5	4659
	10	3985		10	4313		10	4670
	15	3994		15	4323		15	4680
	20	4003		20	4332		20	4691
	25	4012		25	4341		25	4701
	30	4020		30	4351		30	4711
	35	4029		35	4361		35	4722
	40	4038		40	4370		40	4733
	45	4047		45	4380		45	4743
	50	4056		50	4390		50	4754
	55	4065		55	4399		55	4764
56	00	4074	59	00	4409	62	00	4775
	5	4083		5	4419		5	4789
	10	4092		10	4428		10	4796
	15	4101		15	4438		15	4807
	20	4110		20	4448		20	4818
	25	4119		25	4458		25	4829
	30	4128		30	4468		30	4839
	35	4137		35	4478		35	4850
	40	4146		40	4487		40	4861
	45	4155		45	4497		45	4872
	50	4164		50	4507		50	4883
	55	4173		55	4517		55	4894
57	00	4182	60	00	4527	63	00	4905

Lat.		Merid parts.	Lat.		Merid parts.	Lat.		Merid parts.
d	m		d	m		d	m	
63	5	4916	66	5	5336	69	5	5809
	10	4927		10	5348		10	23
	15	4938		15	5361		15	37
	20	4949		20	5373		20	51
	25	4960		25	5386		25	65
	30	4972		30	5398		30	79
	35	4983		35	5411		35	94
	40	4994		40	5423		40	5908
	45	5005		45	5436		45	23
	50	5017		50	5449		50	37
	55	5028		55	5461		55	52
64	00	5039	67	00	5474	70	00	66
	5	5051		5	5487		5	5981
	10	5062		10	5500		10	5996
	15	5074		15	13		15	6010
	20	5085		20	20		20	6025
	25	5097		25	39		25	6040
	30	5108		30	52		30	6055
	35	5120		35	65		35	6070
	40	5132		40	78		40	6085
	45	5143		45	91		45	6100
	50	5155		50	5604		50	6115
	55	5167		55	18		55	6131
65	00	5179	68	00	31	71	00	6146
	5	5191		5	44		5	6161
	10	5203		10	58		10	77
	15	5214		15	71		15	92
	20	5220		20	85		20	6208
	25	5238		25	98		25	24
	30	5250		30	5712		30	39
	35	5263		35	26		35	55
	40	5275		40	39		40	71
	45	5287		45	53		45	87
	50	5299		50	67		50	6303
	55	5311		55	81		55	19
66	00	5324	69	00	95	72	00	35

Of Mercators Sailing.

CHAP. IX.

Concerning the Use and Application of the Table of Meridional Parts, *in some Problems of Sailing by* Mercators *Chart, performed by the Artificial Tables of Sines and Tangents, and by* Gunters Ruler.

These Tables of *Meridional Parts* are deduced from those of Mr. *Wrights*, in his Book of *The Correction of Errors in Navigation*, and are set down to every fifth minute, to 72 degrees of Latitude both North and South, and may thus be used.

Problem I.

To find what *Meridional Parts* are contained in any difference of Latitude.

By the Tables of *Meridional Parts*.

Look the *Meridional Parts* answering to each respective Latitude given, and substract the lesser from the greater, and the remainder is the number of *Meridional Parts* contained in the difference of Latitude in the places proposed.

Example.

Suppose the Latitude of the *Lizard* be given, which is 50, and the Latitude of the *Barbadoes* be also given, which is 13 deg. 12′.

Therefore in Tables look for each reſpective Latitude, and you will find for the Latitude of 50, that the *Meridional Parts* anſwering thereto, are 3475

And for the Latitude of 13 deg. 12 min. you will find, 0799

Which being ſubſtracted from the greater Latitude, there remains 2676, the *Meridional Parts* contained in their difference of Latitude. 2676

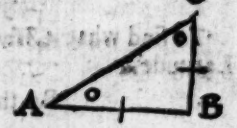
Performed by *Gunters* Ruler.

Extend the Compaſſes upon the *Meridian* Line from the Latitude of 13 deg. 12 min. unto the other Latitude of 50 deg. 00′; this diſtance being between the Compaſſes meaſured upon the Æquinoxial Line or Line of Equal Parts, will be 44 deg. 36 min. which being multiplied by 60, produceth 2676, the *Meridional Parts* contained in the difference of Latitude.

Probleme 2.

The Latitudes and difference of Longitude between two places being given, to find the Rhomb and diſtance.

Suppoſe the Latitude of the *Lizard* to be, 50 deg. 00 min.
And the latitude of the *Barbadoes* to be 13 deg. 12 min.
The diff. of Longit. we will ſuppoſe to be 54 deg. 57 min.
to the Weſtward of the Meridian of the *Lizard*.



In the annexed Triangle A B C, let A repreſent the *Lizard*, and A B the paralel thereof, C the Iſland of *Barbadoes*, and C B the Meridian thereof. C B is the difference of Latitude 36 d. 48′. A B the diff. of Longitude 44 deg. 57 min. the Angles at A and C are required, and the ſide A C the diſtance upon the Rhomb.

Therefore multiply the difference of Longitude by 60, the number of miles in one degree of the Æquinoctial, and the Product will be 3297 for the *Merid. Parts* contained in the difference of Longitude.

Then find the difference of Latitude by the Directions in the firſt Problem, and you will find them to be 2676: ſo that in the Triangle A B C, the Side A B is ſuppoſed to be 3297 parts, and the Side B C, 2676 ſuch parts.

Re-

Reſolved thus, by the fourth caſe of *Triangles* aforegoing.

By Artificial Numbers.

As the difference of Latitude in parts BC 2676,	*Log.* 3,42748
Is to Radius,	10,
So is the diff. of Longitude in parts A B 3297,	13, 51811
To the Tangent of the Rhomb 50 d. 56 m.	10, 09063

which is North-Eaſt, 5 deg. 56 min. more Eaſterly, the Complement of which is S.W. 50 deg. 56 min. more weſterly, the Courſe from the *Lizard* to the *Barbadoes*.

Performed by *Gunters* Ruler.

Extend the Compaſſes upon the Line of Numbers from 3676 the difference of Latitude, unto 3297, the difference of Longitude; the ſame extent being applied on the Line of Tangents, with one foot in the Tangent of 45, the other foot will reach unto the Tangent of 50 deg. 56 min.

2dly, For the Diſtance in the Rhomb.

Reduce the Difference of Latitude into miles, by multiplying the degrees of the Difference of Latitude by 60, and to the Product add the minutes, the ſum is 2208 miles.

Then by the ſecond caſe of Plain Triangles aforegoing,

The Proportion by Artificial Numbers is,

As Sine Complement, the Rhomb 39 d. 04 m. Sine A,	9, 79949
is to the difference of Lat. 2208 miles, *Log.*	3, 33399
ſo is Radius	10,
	13, 33399
to the diſtance A C, 3424 miles,	3, 53450

which is 1141 Leagues and 1 Mile,
which is the Diſtance meaſured in the Rhomb.

Performed by *Gunters* Ruler.

Extend the Compaſſes upon the Line of Sines, from 39 deg. 4. min. the Co-Sine of the Courſe, unto the difference of Latitude in Miles, which is 2208 on the Line of Numbers (Croſs-wiſe), the ſame extent will

will reach from Radius or Sine of 90, unto 3424, on the Line of Numbers; which is the Number of Miles contained in the distance between the two places.

Probleme 3.

The Latitudes of two Places and their Distance given, to find the Rhomb and difference of Longitude.

Suppose I sail from the *Lizard* upon some point of the Compass to the Westward of the Meridian thereof 3416 miles, and then I find my self in the Lat. of 13 deg. 12 min.

I demand upon what point of the Compass I have made my way good, and how much my difference of Longitude is?

In the aforegoing Triangle A B C the diff. of Lat. B C, 36 d. 48 m. being reduced into Miles, is 2208 Miles.

The Proportion is by the Artificial Tables,

As the distance sailed 3424 miles, *Log.*	13,53453
is to Radius	10,
so is the diff. of Lat. 2208, miles,	13,33399
to the Co-Sine of the Rhomb, Sine A, 39 d. 04 m.	9,79946

By *Gunters* Ruler.

Extend the Compasses upon the Line of Numbers from 3424 the distance sailed, unto 2208 the difference of Lat. in Miles, the same extent will reach from Radius or Sine of 90 on the Line of Numbers, and the other foot shall reach to 39 deg. 4 m. Co-Sine of the Course.

2dly, For the Difference of Longitude,

Find by the first Probleme what *Meridional Parts* are contained in the difference of Latitude, which are 2676. Then say,

As Radius	10,
is to the difference of Lat. in parts 2676, *Log.*	3,42748
so is the Tangent of the Rhomb at C 50 deg. 56 min.	10,09059
to the difference of Longitude in parts 3297,	13,51807

which parts being reduced into degrees, by dividing them by 60, the quotient will be 54 deg. and in the remainer there will

be 57, which are the minutes which is the difference of Longitude required.

By *Gunters* Ruler.

Extend the Compaſſes from 2676, the difference of Latitude on the Line of Numbers, unto 50 deg. 56 min. on the Line (Croſs-wiſe) of Tangents, the ſame extent being extended from the Tangent of 45 Croſs-wiſe, will reach to 3297 the difference of Longitude on the Line of Numbers.

Probleme 4.

The Rhomb and Latitude of two places being given, to find their diſtance and difference of Longitude.

Suppoſe I ſail from the *Lizard* being in the Latitude of 50 S W. 5d. 56'. more weſterly, until I find my ſelf in the Latitude of 13 deg. 12 min.

I demand what diſtance I have ſailed, and how much I have altered my Longitude?

The Diſtance is found as in the later part of the ſecond Probleme, thus: The difference converted into miles, is 2208 miles.

Then ſay,

As the Sine Comp. of the Rhomb, Sine A 39 d. 04'.	9, 79949
is to the difference of Latitude 2208 miles, BC	13, 33399
ſo is Radius	10,
to the diſtance A C, 3424 miles.	3, 53450

The difference of Longitude may be found as in the later part of the third Probleme by this proportion, as Radius to the difference of Longitude in minutes.

By *Gunters* Ruler.

Extend the Compaſſes upon the Line of Sines from the Co-ſine of the Courſe 39 deg. 04 min. to Radius; the ſame extent ſhall reach upon the Line of Numbers from 2208 the difference of Lat. in miles to 3424 the diſtance in miles.

Probleme 5.

The difference of Longitude, the Rhomb and one Latitude given, to find the other Latitude and diſtance.

Supp-

Suppose I sail from the *Lizard*, being in the Latitude of 50d 00′, S W. 5d 56′ more westerly, till I have altered my Longitude 54 deg. 57 min. How much have I depress the Pole? and how far am I from the *Lizard*?

Reduce the difference of Longitude into minutes by 60, and it will produce 3297.

Then the proportion is,

As the Tangent of the Rumb at C 50d 56′	10, 09059
is to the diff. of Longitude in parts 3297 A B Log.	13, 51811
so is Radius,	10,
	13, 51811
to the Diff. of Latitude in parts, 2676 B C	3, 42752

Now the Meridional parts answering to the Latitude of 50d 00′, are 3475: from which substracting 2676, the parts here found, there remains 799; against which I find in the Tables aforegoing 13d 12′, the Latitude of the place where I am now come: so that the difference of Latitude is 36 deg. 48 min.

By *Gunters* Ruler.

Extend the Compasses from the Tangent of 45 unto the Tangent of 50 deg. 56 min. the same Extent shall reach from 3297, the difference of Longitude, unto 2676 the difference of Latitude.

Secondly, *for the Distance.*

Having already the Rumb and diff. of Latitude, it may be found as in the 2d and 4th *Problems*, saying:

As *Sine, Complement*, the *Rumb* 39 deg. 4 min.	9, 79949
is to the difference of Latitude 2208 miles,	3, 33399
so is Radius	10,
	13, 33399
to the distance 3414 miles,	3, 53450

By *Gunters Ruler.*

Extend the Compasses upon the line of *Sines*, from the Sine of 39 deg. 4 min. to Radius or sine of 90 deg. the same Extent shall reach from 2208, the difference of Latitude, to 3424 miles, the distance between the *Lizard* and the *Barbadoes*.

Problem

Probleme 6.

The Rhomb and distance, and one Latitude given: to find the other Latitude, and difference of Longitude.

Suppose I sail S.W. 5 deg. 56 min. more westerly 3424 miles, and then find my self in the Latitude of 13 deg. 12 min. I demand the Latitude of the place from whence I came, and the difference of the Longitude.

First, for the difference of Latitude. The proportion is,

As Radius	10,
Is to the distance run 3424 miles,	3,53450
So is the *Sine Comp.* of the Rhomb, 39 deg. 49 min.	79949
To the difference of Latitude 2208.	1,333399

Which being divided by 60, and converted into degrees, produceth 36 deg. 48 min. the difference of Latitude required, which being added to 13 deg. 12 min. makes 50 deg. 00′, the latitude of the first place.

The difference of Longitude is found as before, in the third *Problem*, saying;

As Radius to the difference of Lat. in Meridional parts,
So the Tangent of the Rhomb to the difference of Longit. in minuts.
So in this Example, the difference of Longitude will be found to be 54 deg. 57 min.

If you desire to convert the difference of Longitude between any two places, into miles, you may do it thus:

Suppose there be two places in the Parallel of 50 deg. 00′, which differ in Longitude 70 deg. 00′ the distance between these two places is demanded.

First, you may understand that the minutes of Longitude in any Parallel are in proportion to the distance in miles, as the Equinoctial is to that Parallel, according to this proportion.

As Radius is in proportion	10,
to the sine Comp. of the Latitude 40 deg. 00′	9, 80806
So is the difference of Longitude 4200 minutes	3, 62325
to the distance in that parallel, 2700	13,43131

By *Gunters Ruler.*

Extend the Compasses upon the Line of Sines, from *Radius* to the Sine of 40 degrees: the same extent upon the Line of Numbers, setting one foot in the difference of Longitude 2200, the other foot will fall upon 2700, which is the distance between the two places in the Parallel of 50 deg. 00′, 70 degrees asunder.

A Table of the Latitude and Longitude of several places, taken from Pico Teneriffa, one of the Canary Islands.

The Names of Places.	*North or South.*	*Lat.* D.	M.	*Longit.* D.	M.
St. Kilda	N	58	02	05	56
The South part of Shotland	N	59	55	13	13
The Texel	N	53	00	20	56
Dover	N	51	05	17	34
Isle of Wight	N	50	24	14	47
Portland	N	50	20	13	46
The Lizard	N	50	00	12	37
Ushant	N	48	30	11	00
Cape de Finesterre	N	43	8	6	58
The Rock of Lisbona	N	38	52	6	43
Cape St. Vincent.	N	37	00	7	20
Gibraltar	N	36	00	10	40
Cape de Blanco	N	20	32	358	56
Cape de Verde	N	14	36	358	50
Serra Leone	N	08	00	3	32
The South side of St. Anne	N	06	40	1	11
Cape de Palmes	N	04	10	10	00
Cape de trees puntas	N	04	06	16	00
Cape Formosa	N	04	10	24	15
The Northermost of the Isle Fernandipo	N	03	25	27	25
The midst of St. Thoma	X	00	00	25	30
Cape Lopus	S	01	00	27	40
Cape de Negro	S	16	00	30	50

The

	North or South.	Lat. D. M.	Longit. D. M.
The Weſter Iſlands.			
The Weſt ſide of Corva	N	40: 0	345:30
The Weſt ſide of Flores	N	39:40	345:30
The Road before Fyal	N	38:50	347:47
The Weſt end of Pico	N	38:40	348:18
The Weſt end of St. George	N	39: 0	348:30
The Weſt end of Tercera	N	30: 0	349:10
The Eaſt end of St. Michaels	N	38: 0	351:40
The Eaſt end of St. Maries.	N	37: 0	351:30
Cape de verde Iſlands.			
The Weſt ſide of St. Antonia	N	17:16	350: 0
The Eaſt point of St. Vincent	N	17:10	350: 8
The Eaſt ſide of St. Lucia	N	16:54	351:40
Iſle Brava	N	14:26	351: 8
Iſle Fogo	N	14:36	351:30
The Eaſt ſide of St. Jago	N	15:10	352:30
The Eaſt ſide of Iſle de Mayo	N	15:20	353: 4
The Eaſt ſide of the Iſle de Sal	N	16:45	353: 4
The Eaſt ſide of Bona viſta	N	16:10	353:24
The Canary Iſlands.			
The Northermoſt part of Ferro	N	27:40	358:25
The Eaſt ſide of Palm	N	28:36	358:43
Gomera	N	28:10	359:15
Pico Teneriſa	N	28:20	0 : 0
The Eaſt end of Madera	N	32:30	0 :10
The Eaſt end of Porto Santto	N	33: 0	1 : 0
The North Eaſt point of Canaria	N	28:10	1 : 0
The North Eaſt Point of Forteventura	N	28:20	2 :50
The Eaſtermoſt part of Lancerotta	N	28:30	3 :10
Tabago the Eaſt Point	N	11:16	317: 2
The Eaſt Point of Teruidad	N	10:30	316:44
The Weſt end of Margaretta	N	10:58	312:44
Cartagena	N	11: 0	299:16
Cape de Honduras	N	16:15	286:54

	North or South.	Lat. D. M.	Longit. D. M.
Barbados	N	13:12	317:40
The South East end of Martineco	N	14:31	316:37
The South East end of Barbada	N	17:36	316: 0
The North West Point of Porto Rico	N	18:40	309:40
The South Point of Spaniola	N	17:40	303:40
The West Point of Spaniola	N	18:16	300: 6
The West end of Cuba	N	22: 0	288:26
Cabo de Florida	N	25:51	272:16
Cape Henry in Virginia	N	37:00	321 : 17
Cape Charles in Virginia	N	37:20	291:12
La Barmuda	N	32:20	314: 0
The East end of the Isles of Sables	N	43:40	323: 0
C de Raxo in New found Land	N	46:36	328:30
Penedo de St. Paulo	N	1: 50	349:28
Vizio	X	0 : 0	348:12
Cabo de St. Augustins	S	8 :40	345:40
Baja de todas Santos	S	13: 0	341:50
Isle do Lobos in the Mouth of the River Plate	S	35: 2	325:50
Ascention	S	8 : 0	4 :30
St. Elena	S	16: 0	13 :50
Cavode bona Esperance	S	34:24	38 :10
C das Agulhas	S	35: 0	39 :30
C das Corintas	S	24 : 0	55 :52
Mozambyque	S	15:10	61 : 5
Surrat	N	21: 4	96 :20
Goa	N	15:40	97 : 0
C. Cormarin	N	7 :52	99 :12
The South West Point of Ceylan	N	6 : 0	101:56
The North West Point of Sumatra	N	5 :30	116: 0
Batavia	S	6 :10	127: 5
The South East Haven in Mauritius	S	21 : 15	76 : 16
C de Roman	S	25: 0	69 :25
I St. Paulo	S	38:30	109: 0

A Table of Northing, Southing, Easting and Westing.

Leagues or Miles Sailed	¼ Point 2d 49 m		½ Point 5d 38 m		¾ Point 8d 26 m		1 Point 11d 15 m		Leagues or Miles Sailed
	N S	E W	N S	E W	N S	E W	N S	E W	
01	00.9	00.0	00.9	00.1	00.9	00.1	00.9	00.2	01
02	01.9	00.1	01.9	00.2	01.9	00.2	01.9	00.3	02
03	02.9	00.1	02.9	00.2	02.9	00.4	02.9	00.5	03
04	03.9	00.2	03.9	00.3	03.9	00.5	03.9	00.7	04
05	04.9	00.2	04.9	00.4	04.9	00.7	04.9	00.9	05
06	05.9	00.2	05.9	00.5	05.9	00.8	05.8	01.1	06
07	06.9	00.3	06.9	00.7	06.9	01.0	06.7	01.3	07
08	07.9	00.3	07.9	00.8	07.9	01.2	07.9	01.5	08
09	08.9	00.4	08.9	00.8	08.9	01.3	08.8	01.7	09
10	09.9	00.4	09.9	00.9	09.8	01.4	09.8	01.9	10
20	19.9	00.9	19.9	01.9	19.7	02.9	19.6	03.9	20
30	29.9	01.4	29.8	02.9	29.6	04.4	29.4	05 8	30
40	39.9	01.9	39.8	03.9	39.5	05.8	39.2	07.8	40
50	49.9	02.4	49.7	04.9	49.4	07 3	49.3	09.7	50
60	59.9	02.9	59.7	05.8	59.3	08.8	59.8	11.7	60
70	69.9	03.4	69.6	06.8	69.2	10.2	68.6	13.6	70
80	79.9	03.9	79.6	07.8	79.1	11.7	78.4	15.6	80
90	89.8	04.4	89.5	08.8	89.0	13.2	88.2	17.5	90
100	99.8	04 9	99.5	09.8	98.9	14.6	98.0	19.5	100
200	199.8	09.8	199.2	19.6	197.8	29.3	196.1	39.8	200

E W	N S	E W	N S	E W	N S	E W	N S
87d 11m		84d 22m		81d 34m		78d 45m	
7½ Points		7½ Points		7½ Points		7 Points	

A Table of Northing, Southing, Easting and Westing.

Leagues or Miles sail'd	1 ¼ Point		1 ½ Point		1 ¾ Point		2 Points		Leagues or Miles sail'd
	14d 4m		16d 52m		19d 41m		22d 30m		
	N S	E W	N S	E W	N S	E W	N S	E W	
01	00.9	00.2	00.9	00.2	00.9	00.3	00.9	00.3	01
02	01.9	00.4	01.9	00.5	01.8	00.6	01.8	00.7	02
03	02.9	00.3	02.8	00.8	02.8	01.0	02.7	01.1	03
04	03.8	00.9	03.8	01.1	03.7	01.3	03.7	01.5	04
05	04.8	01.2	04.7	01.4	04.7	01.6	04.6	01.9	05
06	05.8	01.4	05.7	01.7	05.6	02.2	05.5	02.3	06
07	06.7	01.7	06.7	02.3	06.5	02.3	06.4	02.6	07
08	07.7	01.9	07.6	02.3	07.5	02.9	07.3	03.0	08
09	08.7	02.1	08.6	02.6	08.4	03.3	08.3	03.4	09
10	09.7	02.4	09.5	02.9	09.4	03.3	09.2	03.8	10
20	19.4	04.8	19.1	05.8	18.8	06.7	18.4	07.6	20
30	29.1	07.2	29.7	08.7	28.2	10.1	27.7	11.4	30
40	38.8	09.7	38.2	11.6	37.6	13.4	36.9	15.3	40
50	48.5	12.1	47.8	14.5	47.0	16.8	46.1	19.1	50
60	58.2	14.5	57.4	17.4	56.1	20.2	55.4	22.3	60
70	67.9	17.0	66.9	20.3	65.9	23.5	64.6	26.7	70
80	77.6	19.4	76.5	23.2	75.3	26.9	73.9	30.6	80
90	87.3	21.8	86.1	26.1	84.7	30.3	83.1	34.4	90
100	97.0	24.2	95.6	29.0	94.1	33.6	92.3	38.2	100
200	194.0	48.5	191.3	58.4	188.3	67.3	184.7	76.5	200

E W	N S	E W	N S	E W	N S	E W	N S
75d 56m		73d 7m		70d 19m		67d 30m	
6 ¼ Points		6 ⅓ Points		6 ½ Points		6 Points	

A Table of Northing, Southing, Easting and Westing.

Leagues or Miles Sail'd	2¼ Points 25 d 19 m		2½ Points 28 d 07 m		2¾ Points 30 d 56 m		3 Points 33 d 45 m		Leagues or Miles Sail'd
	N S	E W	N S	E W	N S	E W	N S	E W	
01	00.9	00.4	00.8	00.4	00.8	00.5	00.8	00.5	01
02	01.8	00.8	01.7	00.9	01.7	01.0	01.6	01.1	02
03	02.7	01.2	02.6	01.4	02.5	01.5	02.4	01.6	03
04	03.6	01.7	03.5	01.8	03.4	02.6	03.3	02.2	04
05	04.5	02.1	04.4	02.3	04.2	02.5	04.1	02.7	05
06	05.4	02.5	05.2	02.8	05.1	03.0	04.9	03.3	06
07	06.3	02.9	06.1	03.3	06.0	03.6	05.8	03.8	07
08	07.2	03.4	07.0	03.7	06.8	04.1	06.6	04.3	08
09	08.1	03.8	07.9	04.2	07.7	04.6	07.4	05.0	09
10	09.0	04.2	08.8	04.7	08.5	05.4	08.3	05.5	10
20	18.7	08.5	17.6	09.4	17.1	10.2	16.6	11.1	20
30	27.1	12.8	26.4	14.1	25.7	15.4	24.9	16.6	30
40	36.1	17.1	35.2	18.8	34.3	20.5	33.2	22.2	40
50	45.1	21.3	44.9	23.5	42.8	25.7	41.5	27.7	50
60	54.2	25.6	52.9	28.2	51.4	30.8	49.8	33.3	60
70	63.2	29.9	61.7	32.9	60.4	35.9	58.2	38.8	70
80	72.3	34.2	70.5	37.7	68.6	41.1	66.5	44.4	80
90	81.3	38.4	79.3	42.4	77.1	46.2	74.8	50.0	90
100	90.3	42.7	88.1	47.1	85.7	51.4	83.1	55.5	100
200	180.7	85.5	176.3	94.2	171.5	103.0	166.2	110.1	200
	E W	N S	E W	N S	E W	N S	E W	N S	
	64 d 41 m		61 d 52 m		59 d 4 m		56 d 15 m		
	5 ¼ Points		5 ½ Points		5 ¾ Points		5 Points		

A Table of Northing, Southing, Easting and Westing.

Leagues or Miles Sail'd	3¼ Points 36 d 34 m		3½ Points 39 d 22 m		3¾ Points 42 d 11 m		4 Points 45 d 0 m		Leagues or Miles Sail'd
	N S	E W	N S	E W	N S	E W	N S	E W	
01	00.8	00.6	00.7	00.6	00.7	00.6	00.7	00.7	01
02	01.6	01.1	01.5	01.2	01.4	01.3	01.4	01.4	02
03	02.4	02.7	02.3	01.9	02.2	02.1	02.1	02.1	03
04	03.2	02.3	03.0	02.5	02.9	02.6	02.8	02.8	04
05	04.2	02.9	03.8	03.1	03.7	03.3	03.5	03.5	05
06	04.8	03.5	04.6	03.8	04.4	04.3	04.2	04.2	06
07	05.6	04.1	05.4	04.4	05.1	04.7	04.9	04.9	07
08	06.4	04.7	06.1	05.7	05.9	05.3	05.6	05.6	08
09	07.2	05.3	06.9	05.7	06.6	06.4	06.5	06.5	09
10	08.3	05.9	07.7	06.3	07.4	06.7	07.1	07.1	10
20	16.6	11.9	15.4	12.6	14.8	13.4	14.1	14.1	20
30	24.9	17.8	23.1	19.0	22.2	20.1	21.2	21.2	30
40	32.1	23.8	30.9	25.3	29.6	26.8	28.2	28.2	40
50	40.1	29.7	36.6	31.7	37.0	23.5	35.3	35.3	50
60	48.1	35.7	46.3	38.0	44.4	40.2	42.4	42.4	60
70	56.2	41.6	54.1	44.4	51.8	47.0	49.4	49.4	70
80	64.2	47.6	61.8	50.7	59.2	53.7	56.5	56.5	80
90	72.2	53.6	69.5	57.0	66.6	60.4	63.6	36.6	90
100	80.3	59.5	77.3	63.4	74.8	67.1	70.7	70.7	100
200	160.6	119.1	154.6	126.8	148.1	134.3	141.4	141.4	200
	E W	N S	E W	N S	E W	N S	E W	N S	
	53 d 26 m		50 d 37 m		47 d 45 m		45 d 0 m		
	4¼ Points		4½ Points		4¾ Points		5 Points		

Of the uſe of the Table of Northing, Southing, Eaſting and Weſting.

This Table needs little explanation, the Title beſpeaks the uſe of it, to all that are but meanly converſant in the Rudiments of Navigation.

This Table conſiſts of four Parts, wherein the Courſe is reckoned from the Meridian, by every quarter Point, being continued in the head of the Table to 4 Points, and from thence proceeding in the foot of the Table to 8 Points from the Meridian. The two Marginal Columns, are the Leagues or Miles ſailed; and in the middle Columns, is the difference of Latitude, and departure from the Meridian in Leagues or Miles, and 10th parts, according to the reſpective Courſe, either No. So. East or Weſt, ſignified by the Letters N. S. E. W.

For the Application of this Table.

This Table is uſeful in theſe ſix Propoſitions, *viz.*

1. The Courſe and Diſtance given to find the difference of Latitude, and the departure from the Meridian.
2. The difference of Latitude and Diſtance given, to find the Courſe and Departure from the Meridian.
3. The difference of Latitude and Courſe given, to find the diſtance and departure from the Meridian.
4. The Departure and Courſe given, to find the diſtance and difference of Latitude.
5. The Departure and Diſtance given, to find the Courſe and Difference of Latitude.
6. The Difference of Latitude, and Departure from the Meridian given, to find the Courſe and Diſtance.

It is not neceſſary to inſiſt upon all theſe Propoſitions, but upon thoſe only which are moſt uſeful, the reſt may be readily conceived.

1. The Diſtance and Courſe given, to find the Difference of Latitude, and Departure.

1. *Example.*

Suppoſe a Ship ſail 50 Leagues or Miles, So. Weſterly 6 ½ Points; I demand the Difference of Latitude, and departure from the Meridian, or the Leagues or Miles Southing and Weſting?

Againſt 60 Leagues or Miles, over 6 ½ Points, (in th: Table) you

will find 14.5 over the Letters N. S. shewing, that the Difference of Latitude or Southing is 14.5 or $\frac{5}{10}$ Leagues or Miles, and over the Letters E. W. 47.8 or $\frac{8}{10}$ shewing, that the Departure is 47.8 Leagues or Miles.

2. *Example.*

A Ship sails 125 Miles No. Easterly 7 $\frac{1}{2}$ Points; I demand the Northing and Westing? You must take this out of the Table as follows, *viz.*

Miles	100	09.8	99.5
	20	1.9	19.9
	5	0.4	4.7
Miles	125	12.1	124.1

It is taken out of the Table at thrice, and the three sums added together, gives the total of No. and Easting for the whole distance of 125 Miles, *viz.* 12.1 Miles Northing, and 124.1 Easting?

2. The Course and Difference of Latitude given; to find the Distance and Departure.

Example.

A Ship sails So. Westerly 6 $\frac{1}{2}$ Points, till her difference of Latitude, or Southing, be 14 $\frac{1}{2}$ Leagues, or 14.5 Leagues. What is the Distance sailed, and what her Departure, or Westing.

Look into the Table, in the Column of 6 $\frac{1}{2}$ Points, until you find 14.5 over the Letters N. S. (being the Southing) in the same Parallel, in the Column of Leagues (or Miles) you will find 50, shewing the distance to be 50 Leagues: and in the same Column of 6 $\frac{1}{2}$ Points, where you found 14.5 you will find in the same Parallel 47.8 over the Letters E. W. signifying that the Westing is 47.8 Leagues.

3. The Distance and Difference of Latitude given, to find the Course and Departure.

Example.

A Ship sails 50 Leagues between the South and West, till her difference of Latitude be 14.5 Leagues. What shall her Course and Departure be?

Cross the Table in the Distance given, *viz.* 50 Leagues (in the

Column

Column of Leagues or Miles) towards the right or left hand, till you find 14.5 in one of the middle Columns, in the same Parallel with your distance, (50 Leagues) and in that Column, where you find the Letters N. S. either in the Head or Foot of the Table, in the same Rank with your Difference of Latitude, (14.5) there you shall see the Course joyned with the Letters N. S. *viz.* 6 ½ Points; and in the same Column of 6 ½ Points, you shall find your departure 47.8 over the Letters E. W. and in the same Parallel with your Distance and Difference of Latitude.

Thus much for the General Use.

The Particular Application of this Table may be in the conducing much to the ease forming of a Sea-Reckoning, the Course computed by Points and quarter Points from the Meridian.

To instance in an Example from the *Lizard* to the *Barbadoes*.

The Title of your Journal may be as on the other side.

A Journal of our Voyage intended, by Gods Permission, from the Lizard, *in the Latitude* 50° 00′ *to the* Barbadoes, *in Latitude* 13° 22′ North.

March 22. 69. The *Lizard* bears North, and is distant 10 Leagues.

Days	Month and Latitude by Observation.	Course corrected.	Distance	Northing	Southing	Easting	Westing	Lat. by dead Reck.	Diff. of Long. by dead Reck.
22	*March*, 1669.	The *Lizard* bears North Distant 30 Miles.							
		Points.	Miles	M	Miles	M	Miles	d. m.	d. m.
22	*March.*	*Liz.* S.	030.0		030.0			49.30	
		S. W.	100		070.7		070.7		
23		4 Points	10		007.1		007.1	48.11	
			2		001.4		001.4		
	d : m	S. W. 3 1/2	070		054.1		044.4		
24	47 : 00	Points.	2		001.4		001.2	47.16	
24	Correct. by Observat.				016.0		012.0	47.00	
24		Sum			180.8		136.8	47.00	03.26
25		S. W. 3 p.	096		079.7		053.3	45.40	
26		S. W. 3 p.	079		065.6		043.8	44.35	
27	42 : 37	S. W. 3 p.	138		114.6		076.4	42.40	
28		S.W. 2 1/2 p.	129		110.5		066.2	40.50	
29		S. W. 2 p.	072		066.4		027.4	39.43	
30	37:44	S.W. 2 1/2 p.	101		089.8		048.0	38.13	
30	Correct. by Observat.				029.0		017.0	37.44	
30		Sum			555.6		332.1	37.44	07.31
01	*April.*	S. W. 4 p.	085		060.0		060.0	36.44	
02		S. W. 6 p.	020		007.6		018.4	36.37	
03		S.W. 1 1/2 p.	032		031.6		009.2	36.05	
04	34 : 10	S. W. 1 p.	120		117.6		023.4	34.07	
				M		M			
	Correct. by Observat.			03		01		34.10	
		Sum			216.8		111.0		
		Difference			213.8		110.0	34.10	02.15

Dayes	Month and Latit. by Observat.	Course Corrected.	Distance.	Northing.	Southing.	Easting.	Westing.	Latit. by dead Reck.	Diff. of Long. by dead Reck.
04	*April* on the other side.							34:10	13:12
05		S.W. 1½ p	164		157.7		047.9	31:32	
06	29°:37'	S. W. 2 p	125		115.3		047.7	29:37	
07		S. W. 3 p	110		091.4		061.0	28:06	
08		S. W. 3 p	112		101.3		067.7	26:25	
09	24:43	S. W. 4 p	116		082.0		082.0	25:03	
09	Correct. by Observat.				020.0		011.0	24:43	
09			Sum		567.7		316.9	24:43	07:04
10		S. W. 4 p	097		068.6		068.6	23:35	
11		S. W. 4 p	096		067.8		067.8	22:28	
12		S. W. 4 p	114		080.6		080.6	21:08	
13		S. W. 4 p	118		083.4		083.4	19:45	
14		S. W. 5 p	110		061.0		091.0	18:44	
15		S. W. 6 p	091		034.7		084.0	18:30	
16		S. W. 6 p	090		034.4		083.1	17:35	
17		S. W. 6 p	084		032.1		077.6	17:03	
18		S. W. 6 p	107		040.8		098.7	16:22	
19		S. W. 6 p	103		039.3		095.0	15:43	
20	14:43	S. W. 6 p	116		044.3		107.0	14:59	
20	Correct. by Observat.				016.0		026.0		
20			Sum		603.0		962.8	14:43	16:47
20	Carried to the other side.							14:43	37:29

Dayes

Dayes	Month and Latit. by Observat.	Course corrected.	Distance.	Northing.	Southing.	Easting.	Westing.	Latitude by dead Reckoning	Diff. of Long. by dead Reck.
20	*April.*	Brought from the other side.						14.43	37.29
21		S.W.7 p	110		021.4		107.8	14.22	
22		S.W.7 p	120		023.4		117.6	13.59	
23		S.W.7 p	106		020.6		103.8	13.39	
24		S.W.7 p	100		019.5		098.0	13.20	
25		S.W.7 p	32		006.1		031.3	13.12	
25		Sum			091.0		458.5	13.12	07.52
26		W.	136				136.0		
27		W.	130				130.0		
28		W.	116				116.0		
29		W.	128				128.0		
30	*Barbados* bears W. distant 16 miles				016.0			13.12	08.32
	The Lat. and Diff. Merid. is							10° 12′ No.	54° 00′ W

The Explanation of this Tabular Journal.

In this Journal, or Sea-Reckoning, there are ten Columns; the first Column contains the Dayes; the second the Month and Latitude by Observation; the third, the Course Corrected by due Allowance of Lee-ward-waye, Variation of the Compass, if there be any, *&c.* the fourth the Distance; the 5th, 6th, 7th, 8th. the Northing, Southing, Easting and Westing; the ninth the Latitude by dead Reckoning; the tenth the Difference of Longitude by dead Reckoning. And this is the usual form of setting down a Reckoning at Sea, in a Book in Folio, wherein the left hand Pages are void, for to write down those occurrances which you shall think fit, of Wind, Weather, and Allowances, *&c.* The right hand Pages are ruled in this or some such like order, and so the Reckoning kept as you see in the Example.

To

To Correct your Latitude by dead Reckoning, by your Latitude by Observation.

Example:

On *March* 24. by clear and good Observation, I find my Latitude to be 47° 00′ whereas by dead Reckoning my Latitude ſhould be 47° 16′ ſo the Difference is 16 minuts more Southerly, therefore I Correct my Latitude by dead Reckoning by my Obſervation, by the Rule of Three, ſaying.

		Co. ar.
As the ſum of the South Column	164.8	Log: 7.78305
Is to the ſum of the Weſt Column	124.1	——2.09621
So is the difference Southerly	16	——1.20412
To the difference Weſterly	12	——1.08338

To find your Longitude in the tenth Column.

In the Example before given of a Journal, we have in the tenth Column, at ſuch time as the Reckoning is Corrected by Obſervation, expreſſed the difference of Longitudes, which will be very requiſite ſo to do, eſpecially if you form your Reckoning according to *Mercator*, which here we ſhall ſhew how to perform.

1. *Caſe.* If the Courſe and both Latitudes be known.

Example:

In the Journal, on *April* 25. you will find the Courſe from the 20th day (the time of the laſt Correction) to the 25th, to be S. W. 7 Points (*&c.*) S. W. 78 deg. 45 min. And the Latitudes to be 14°:43′, and 13°:12′ given to find the difference of Longitude.

Operation.

The Meridional parts anſwering to the Latitude 14°:43′	—— 893
The Meridional parts anſwering to the Latitude 13 : 12	—— 799
The Difference in Meridional parts, is	—— 94

As

As *Radius*, 2. 90 deg. 00 min. the Log.	10.00000
To 94 the difference in Meridional parts	1.93712
So is the Tangent 78 deg. 45 min. Tangent of the Course	10.70133
To the difference of Longitude in minuits	22.67445

Being 472 min. which divided by 60, gives 7 deg. 52 min.

2. *Case.* If the Courses do not much differ, and both Latitudes given.

Example.

March 24, Both Latitudes are 50 deg. 00 min. and 47 deg. 00 m. the difference 3 deg. or 180 min. the Course South Westerly, between 3 ½ and 4 Points, the difference of Longitude required.

Operation.

The Meridional parts answering to 50 deg. are	3475
The Meridional parts for 47 deg.	3203
The difference in Merid. parts	272

	Course.
As 180 the difference of Latitude in min. Log.	7.74473
To 272 the Meridional difference	2.43456
So 136.8 the departure or Westing	2.13608
To 206 the difference of Longitude in min.	2.31532

3. *Case.* If the Courses do much differ, the Northing or Southing, and Easting or Westing, with both Latitudes given.

Example.

April 20. In the Journal aforesaid, from the tenth to the twentieth day, the Course is betwe en S. W. and W. S. W. *&c.* S.W. 4 Points, and S. VV. 6 Points, and both Latitudes are 24 deg. 43. min. and 14 deg. 43 min. The Solution of this Proposition requires a two-fold Operation by the Rule of Proportion.

Operation

Operation.

1. To find the Course Contracted.

	Coisr.
As 603.0 the sum of the South Column Log.	7.21969
To 962.8 the sum of the West Column:	2.98353
So Rad.	
To Tangent 57°:56′ the Tangent of the Course;	10.20322

2. The Meridional parts for the Latitude 24°:43′ 1531
The Meridional parts for the Latitude 14°:43′ 89.3
The diff. Merid. parts. 638

As Rad.	
To 638. the diff. Merid. parts:	Log. 2.80482
So Tangent 57°:56′ Tangent of the Course;	10.20322
To 1007 the diff. Long. in min.	3.00804

1007 divided by 60, is 6 deg. 47 min.

A New and Exact Kalendar, shewing the *Prime*, *Epact*, *Dominical Letters*, and *Leap-years*, for 28 years. Also the dayes of the Month, and remarkable dayes: With Tables of the Suns true place in the Ecliptick; and the Declination of the Sun for 60 years to come, and may indifferently serve for as many more; Calculated from those Excellent Tables of Mr. *Tho. Street*, in his Book called, *Astr. Car.* &c.

Years	Prime.	Epact.	Domin.	Cycle ☉	Shrove-Sunday.	Easter-Sunday.	Whit-Sunday.
1669	17	7	C	26	21	*Apr.* 11	*May* 30
1670	18	18	B	27	13	3	22
1671	19	29	A	28	5	23	*June* 11
1672	1	11	G F	1	*Mar.* 18	7	*May* 26
1673	2	22	E	2	*Feb.* 9	*Mar.* 30	18
1674	3	3	D	3	*Mar.* 1	*Apr.* 19	*June* 7
1675	4	14	C	4	*Feb.* 14	4	*May* 23
1676	5	25	B A	5	6	*Mar.* 26	4
1677	6	6	G	6	25	*Apr.* 15	*June* 3
1678	7	17	F	7	10	*Mar.* 31	*May* 19
1679	8	28	E	8	*Mar.* 2	*Apr.* 20	*June* 8
1680	9	9	D C	9	*Feb.* 22	11	*May* 30
1681	10	20	B	10	13	3	22
1682	11	1	A	11	26	16	*June* 4
1683	12	12	G	12	18	8	*May* 27
1684	13	23	F E	13	10	*Mar.* 30	18
1685	14	4	D	14	*Mar.* 1	*Apr.* 19	*June* 7
1686	15	15	C	15	*Feb.* 14	4	*May* 23
1687	16	26	B	16	6	*Mar.* 27	15
1688	17	7	A G	17	26	*Apr.* 15	*June* 13
1689	18	18	F	18	10	*Mar.* 31	*May* 19
1690	19	29	E	19	*Mar.* 2	*Apr.* 20	*June* 8
1691	1	11	D	20	*Feb.* 23	12	*May* 31
1692	2	22	C B	21	7	*Mar.* 27	15
1693	3	3	A	22	26	*Apr.* 16	*June* 4
1694	4	14	G	23	18	8	*May* 27
1695	5	25	F	24	3	25	12
1696	6	6	E D	25	23	12	31

January

January hath XXXI dayes.

Month dayes.	Week dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year 1669.		Second Year 1670.		Third Year 1671.		Leap Year 1672.	
			☉ Pla	☉ dec.	☉ pla.	☉ dec	☉ pla.	☉ dec	☉ pla.	☉ dec
			D M	D M	D M	D. M.	D. M.	D. M.	D. M.	D. M.
			♒	South.	♒	South.	♒	South.	♒	South.
1	A	*New years day*	21 58	21 42	21 43	21 45	21 28	21 47	21 13	21 49
2	B		22 59	21 32	24 44	21 35	22 29	21 37	22 15	21 39
3	C		24 00	21 22	23 45	21 24	23 31	21 27	23 16	21 29
4	D		25 01	21 11	24 47	21 14	24 32	21 16	24 17	21 19
5	E		26 03	21 0	25 48	21 02	25 33	21 05	25 18	21 08
6	F	Epephania.	27 04	20 48	26 49	20 51	26 34	20 54	26 19	20 56
7	G		28 05	20 36	27 50	20 39	27 35	20 42	27 20	20 45
8	A		29 06	20 24	28 51	20 27	28 36	20 30	28 21	20 33
9	B	☉ in Aquar.	♒ 07	20 11	29 52	20 14	29 37	20 17	29 22	20 20
10	C	Arch B. *Can.*	01 08	19 57	♒ 53	20 01	♒ 38	20 04	♒ 23	20 07
11	D	Beh. 1644.	02 09	19 44	01 54	19 47	01 39	19 51	01 25	19 54
12	E		03 10	13 30	02 25	13 33	02 40	19 37	02 26	19 40
13	F		04 11	19 16	03 56	19 19	03 41	19 23	03 27	19 26
14	G		05 12	19 01	04 57	19 05	04 42	19 08	04 28	19 12
15	A		06 13	18 46	05 58	18 50	05 43	18 53	05 29	18 57
16	B		07 14	18 31	06 59	18 34	06 44	18 38	06 30	18 42
17	C	South arms of	08 15	18 15	08 00	18 19	07 45	18 23	07 31	18 26
18	D	the Crab. 13	09 16	17 59	09 01	18 03	08 46	18 07	08 31	18 11
19	E	8. N.	10 17	17 43	10 02	17 47	09 47	17 51	09 32	17 55
20	F		11 18	17 26	11 03	17 30	10 48	17 34	10 33	17 38
21	G		12 18	17 09	12 04	17 13	11 49	17 17	11 34	17 21
22	A		13 19	16 52	13 04	16 56	12 50	17 00	12 35	17 04
23	B	Term begins.	14 20	16 34	14 05	16 39	13 51	16 43	13 36	16 47
24	C	Hydra's heart 7:12. S.	15 20	16 16	15 06	16 21	14 51	16 25	14 37	16 30
25	D		16 22	15 58	16 07	16 03	15 52	16 07	15 37	16 12
26	E		17 22	15 40	17 08	15 44	16 53	15 49	16 38	15 53
27	F		18 23	15 21	18 08	15 26	17 54	15 30	17 39	15 35
28	G		19 24	15 02	19 09	15 07	18 54	15 12	18 40	15 16
29	A		20 24	14 43	20 10	14 48	19 55	14 53	19 40	14 57
30	B		21 25	14 24	21 10	14 29	20 56	14 33	20 41	14 38
31	C		22 26	14 04	22 11	14 09	21 56	14 14	21 42	14 19

February hath XXVIII dayes.

Month dayes.	Week Dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669.				Second Year 1670.				Third Year, 1671.				Leap Year, 1672.			
			☉ pla.		☉ dec		☉ pla.		☉ dec		☉ pla.		☉ dec		☉ pla.		☉ dec	
			D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
			♒		South.		♒		South.		♒		South.		♒		South.	
1	D		23	26	13	44	23	12	13	49	22	57	13	54	22	42	13	59
2	E		24	27	13	24	24	12	13	29	23	58	13	34	23	43	13	39
3	F	Lyons heart	25	27	13	04	25	13	13	09	24	58	13	14	24	43	13	19
4	G	13° 36′ N.	26	28	12	44	26	13	12	49	25	59	12	54	25	44	12	59
5	A	Lyons neck	27	28	12	23	27	14	12	28	26	59	12	33	26	44	12	38
6	B	25° 5′ N.	28	29	12	02	28	14	12	07	27	59	12	11	27	45	12	17
7	C		29	29	11	41	29	15	11	46	29	00	11	51	28	45	11	56
8	D	Sol in Pices	♓	30	11	19	♓	15	11	25	♓	00	11	30	29	46	11	35
9	E		01	30	10	58	01	15	11	03	01	01	11	09	♓	46	11	14
10	F		02	30	10	36	02	16	10	42	02	01	10	47	01	46	10	52
11	G		03	31	10	15	03	16	10	20	03	01	10	25	02	47	10	31
12	A		04	31	09	53	04	16	09	58	04	02	10	03	03	47	10	09
13	B	(58° 12′ N.	05	31	09	31	05	16	09	36	05	02	09	41	04	47	09	47
14	C	G. Bear. side	06	31	09	08	06	17	09	14	06	02	09	19	05	47	09	25
15	D	G. Bears back	07	31	08	46	07	17	08	52	07	02	08	57	06	48	09	02
16	E	63° 55′ N.	08	32	08	24	08	17	08	29	08	02	08	35	07	48	08	40
17	F		09	32	08	01	09	17	08	06	09	03	08	12	08	48	08	17
18	G		10	32	07	38	10	17	07	44	10	03	07	49	09	48	07	55
19	A		11	32	07	15	11	17	07	21	11	03	07	27	10	48	07	32
20	B		12	32	06	52	12	17	06	58	12	03	07	04	11	48	07	09
21	C	Lyons back.	13	32	06	29	13	17	06	35	13	03	06	41	12	48	06	46
22	D	22° 22′ N.	14	32	06	06	14	17	06	12	14	03	06	18	13	48	06	23
23	E		15	32	05	43	15	17	05	49	15	03	05	54	14	48	06	00
24	F	*Matthias.*	16	32	05	20	16	17	05	26	16	03	05	31	15	48	05	37
25	G		17	31	04	57	17	17	05	02	17	02	05	08	16	48	05	14
26	A		18	31	04	33	18	17	04	39	18	02	04	44	17	48	04	50
27	B		19	31	04	10	19	17	04	15	19	02	04	21	18	48	04	27
28	C		20	31	03	46	20	16	03	52	20	02	03	58	19	47	04	03
29	D														20	47	03	40

When it is Leap year, *Feb.* hath 29 days, & then St. *Matthias* is on the 25th day.

Week Dayes.	Month Dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669.		Second Year, 1670.		Third Year, 1671.		Leap Yea r 1672.	
			⊙ pla.	⊙ dec	⊙ pla.	⊙ dec	⊙ pla.	⊙ dec	⊙ pla.	⊙ dec
			D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
			♓	South.	♓	South.	♓	South.	♓	South.
1	D	*David.*	21 30	03 23	21 16	03 28	21 02	03 34	21 47	03 16
2	E	L. tayl 16 28 N	22 30	02 59	22 16	03 05	22 01	03 10	22 46	02 52
3	F	G. Bears thigh	23 30	02 35	23 15	02 41	23 01	02 47	23 46	02 29
4	G	55° 36′ N.	24 29	02 12	24 15	02 17	24 01	02 23	24 46	02 05
5	A		25 29	01 48	25 15	02 54	25 00	01 59	25 45	01 42
6	B		26 29	01 24	26 14	01 30	26 00	01 36	26 45	01 18
7	C		27 28	01 01	27 14	01 06	26 59	01 12	27 44	00 54
8	D		28 28	00 37	28 13	00 43	27 59	00 48	28 44	00 30
9	E		29 27	00 13	29 13	00 19	28 58	00 25	29 43	00 07
10	F	Sol in Aries.	♈ 26	*nor* 11	♈ 12	*nor* 05	29 58	00 01	♈ 43	*nor* 17
11	G		01 26	00 34	01 11	00 28	♈ 57	*nor* 23	01 42	00 41
12	A		02 25	00 58	02 11	00 52	01 56	00 46	02 41	01 04
13	B		03 24	01 21	03 10	01 16	02 56	01 10	03 40	01 28
14	C		04 24	01 45	04 09	01 39	03 55	01 34	04 40	01 51
15	D		05 23	02 09	05 08	02 03	04 54	01 57	05 40	02 15
16	E		06 22	02 32	06 08	02 26	05 53	02 21	06 38	02 38
17	F		07 21	02 55	07 07	02 50	06 52	02 44	07 37	03 02
18	G		08 20	03 19	08 06	03 13	07 52	03 08	08 36	03 25
19	A		09 29	03 42	09 05	03 37	08 51	03 31	09 35	03 48
20	B	First in Gr.	10 18	04 05	10 04	04 00	09 50	03 54	10 34	04 12
21	C	Bears Tayl,	11 17	04 29	11 03	04 43	10 49	04 17	11 33	04 35
22	D	57° 50′ N.	12 16	04 52	12 02	04 46	11 48	04 41	12 32	04 58
23	E		13 15	05 15	13 01	05 09	12 47	05 04	13 31	05 21
24	F		14 14	05 38	14 00	05 32	13 46	05 27	14 30	05 44
25	G	*Anun. Mary*	15 13	06 00	14 59	05 55	14 45	05 49	15 29	06 07
26	A		16 12	06 23	15 58	06 18	15 43	06 12	16 28	06 29
27	B	(9° 12′ S.	17 11	06 46	16 56	06 40	16 42	06 35	17 27	06 52
28	C	Virg. Spike.	18 10	07 08	17 55	07 03	17 41	06 57	18 26	07 14
29	D	Second in G	19 08	07 31	18 54	07 25	18 40	07 20	19 24	07 37
30	E	Bears Tayl,	20 07	07 53	19 53	07 48	19 39	07 42	20 23	07 59
31	F	56° 44′ N.	21 06	08 15	20 51	08 10	20 37	08 04	21 22	08 21

April hath XXX dayes.

Month dayes.	Week Dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669.		Second Year 1670.		Third Year, 1671.		Leap Year, 1672.	
			⊙ pla.	⊙ dec	⊙ pla.	⊙ dec	⊙ pla.	⊙ dec	⊙ pla.	⊙ dec
			D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
			♊	North	♊	North	♊	North	♊	North
1	G		22 04	08 37	21 50	08 32	21 36	08 26	22 20	08 43
2	A		23 03	08 59	22 49	08 54	22 34	08 48	23 19	09 05
3	B		24 01	09 21	23 47	09 15	23 33	09 10	24 17	09 26
4	C		25 00	09 42	24 26	09 37	24 32	09 32	25 16	09 48
5	D	3d. in ♐ Bears Tail, 51 d. 3. m. N.	25 58	10 03	25 44	09 58	25 30	09 53	26 14	10 09
6	E		25 57	10 25	26 43	10 20	26 29	10 14	27 13	10 30
7	F		27 55	10 46	27 41	10 41	27 27	10 36	28 11	10 51
8	G	Centaur's should, 35 d. 16 m. S.	28 54	11 07	28 40	11 02	28 25	10 56	29 10	11 12
9	A		29 52	11 27	29 38	11 22	29 24	11 17	♉ 08	11 33
10	B	Sun in Taurus	♉ 51	11 48	♉ 36	11 43	♉ 22	11 38	01 06	11 53
11	C		01 49	12 08	01 35	12 04	01 21	11 58	02 05	12 14
12	D	Arcturus 21 d 1 m. N.	02 47	12 28	02 33	12 23	02 19	12 18	03 03	12 34
13	E		03 45	12 48	03 31	12 43	03 17	12 38	04 01	12 53
14	F		04 44	13 08	04 29	13 03	04 15	12 58	04 59	13 13
15	G		05 52	13 27	05 28	13 23	05 14	13 18	05 58	13 33
16	A		06 40	13 46	06 26	13 42	06 12	13 37	06 56	13 52
17	B		07 38	14 06	07 24	14 01	07 10	13 56	07 54	14 11
18	C		08 36	14 24	08 22	14 20	08 08	14 15	08 52	14 29
19	D		09 34	14 43	09 20	14 38	09 06	14 34	09 50	14 48
20	E	Sou. Ballance 14d 34′ S.	10 32	15 01	10 18	14 57	10 04	14 52	10 48	15 06
21	F		11 30	15 19	11 16	15 15	11 02	15 11	11 46	15 24
22	G		12 28	15 37	12 14	15 33	12 00	15 29	12 44	15 42
23	A		13 26	15 55	13 12	15 51	12 58	15 56	13 42	15 59
24	B		14 24	16 12	14 10	16 08	13 56	16 04	14 40	16 17
25	C		15 22	16 29	15 08	16 25	14 24	16 21	15 38	16 34
26	D	75d 38′ N.	16 20	16 46	16 06	16 42	15 52	16 38	16 36	16 50
27	E	Formoſtguard	17 18	17 02	17 04	16 58	16 50	16 54	17 34	17 07
28	F	Nor. Ballance.	18 16	17 19	18 02	17 15	17 48	17 11	18 32	17 23
29	G	8d 5′ S.	19 14	17 35	19 00	17 31	18 46	17 27	19 29	17 39
30	A		20 11	17 50	19 57	17 46	19 43	17 43	20 27	17 54

May hath XXXI dayes.

Week Dayes.	Month Dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669.		Second Year 1670.		Third Year, 1671.		Leap Year, 1672.	
			☉ pla.	☉ dec	☉ pla.	☉ dec	☉ pla.	☉ dec	☉ pla.	☉ dec
			D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
			♉	North	♉	North	♉	North	♉	North
1	B	*Phil.* & *Jac.*	21 09	18 06	20 55	18 02	20 41	17 58	21 25	18 10
2	C	27d 53′ N.	22 07	18 21	21 53	18 17	21 39	18 13	22 23	18 29
3	D	Luc. Coronæ	23 05	18 35	22 51	18 32	22 37	18 28	23 20	18 39
4	E	Hind. guard.	24 02	18 50	23 48	18 46	23 34	18 43	24 18	18 54
5	F	73d 16′ N.	25 00	19 04	24 46	19 00	24 32	18 57	25 16	19 08
6	G	Serp. Neck.	25 58	19 18	25 44	19 14	25 30	19 11	26 13	19 21
7	A	7d 33′ N.	26 55	19 31	26 41	19 28	26 27	19 25	27 11	19 35
8	B		27 53	19 44	27 39	19 41	27 25	19 38	28 09	19 43
9	C		28 15	19 57	28 36	19 54	28 22	19 51	29 06	20 01
10	D	Sun in Gem.	29 48	20 10	29 34	20 07	29 20	20 04	♊ 04	20 13
11	E		♊ 45	20 22	♊ 32	20 19	♊ 18	20 16	01 01	20 25
12	F		01 43	20 33	01 29	20 31	01 15	20 28	01 59	20 37
13	G		02 40	20 45	02 27	20 42	02 13	20 39	02 56	20 48
14	A		03 38	20 56	03 24	20 53	03 10	20 51	03 54	20 59
15	B		04 35	21 07	04 22	21 04	04 08	21 02	04 51	21 10
16	C	Scorp. heart	05 33	21 17	05 19	21 15	05 05	21 12	05 49	21 20
17	D	25d 35′ S.	06 30	21 27	06 16	21 25	06 03	21 22	06 46	21 30
18	E		07 28	21 37	07 14	21 34	07 00	21 32	07 43	21 39
19	F		08 25	21 46	08 11	21 44	07 57	21 41	08 41	21 18
20	G		09 23	21 55	09 09	21 53	08 55	21 50	09 38	21 57
21	A		10 20	22 03	10 06	22 01	09 52	21 59	10 36	22 06
22	B		11 17	22 11	11 03	22 09	10 49	22 07	11 33	22 13
23	C		12 15	22 19	12 01	22 17	11 47	22 15	12 30	22 21
24	D		13 12	22 26	12 58	22 25	12 44	22 23	13 28	22 28
25	E	Serp. Knee.	14 09	22 33	13 55	22 32	13 41	22 30	14 25	22 35
26	F		15 07	22 40	14 53	22 38	14 39	22 37	15 22	22 42
27	G	Herc. Head.	16 04	22 46	15 50	22 45	15 36	22 43	16 20	22 48
28	A		17 01	22 52	16 47	22 51	16 33	22 49	17 17	22 53
29	B	*K. Ch. II. N.*	17 58	22 57	17 44	22 56	17 31	22 55	18 14	22 58
30	C	& *Re.* 1660.	18 56	23 02	18 42	23 01	18 28	23 00	19 11	23 03
31	D		19 53	23 07	19 39	23 06	19 25	23 05	20 09	23 08

June hath XXX dayes.

Month dayes.	Week dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year 1669.				Second Year 1670.				Third Year 1671.				Leap Year 1672.			
			☉ Pla.		☉ dec.		☉ pla.		☉ dec		☉ pla.		☉ dec		☉ pla.		☉ dec	
			D	M	D	M	D	M	D	M.	D.	M.	D.	M.	D.	M.	D.	M.
			♊		North		♊		North		♊		North		♊		North	
1	E		20	50	23	11	20	36	23	10	20	22	23	09	21	06	23	12
2	F		21	47	23	15	21	33	23	14	21	20	23	13	22	03	23	16
3	G	*Dutch* Engagement, 1652.65	22	45	23	18	22	31	23	17	22	17	23	16	23	00	23	19
4	A		23	42	23	21	23	28	23	20	23	14	23	20	23	57	23	22
5	B		24	39	23	23	24	25	23	23	24	11	23	22	24	55	23	24
6	C		25	36	23	26	25	22	23	25	25	08	23	25	25	52	23	26
7	D	Sagit. Ar. head 30d. 00 m. S.	26	33	23	27	26	19	23	27	26	06	23	27	26	49	23	28
8	E	Drag. head,	27	30	23	29	27	17	23	28	27	03	23	28	27	46	23	29
9	F	51° 36′ N.	28	28	23	29	28	14	23	29	28	00	23	29	28	43	23	30
10	G		29	25	23	30	29	11	23	30	28	57	23	30	29	41	23	30
11	A	Sol in Canc.	♋	22	23	30	♋	08	23	30	29	54	23	30	♋	38	23	30
12	B		01	19	23	30	01	05	23	30	♋	52	23	30	01	35	23	29
13	C		02	16	23	29	02	02	23	29	01	49	23	29	02	32	23	28
14	D		03	14	23	28	03	00	23	28	02	46	23	28	03	29	23	27
15	E		04	11	23	26	03	57	23	26	03	43	23	27	04	26	23	25
16	F		05	08	23	24	04	54	23	25	04	40	23	25	05	23	23	23
17	G	Lyra 38°	06	05	23	22	05	51	23	22	05	37	23	23	06	21	23	21
18	A	30′ N.	07	02	23	19	06	48	23	19	06	34	23	20	07	18	23	18
19	B		07	59	23	16	07	45	23	15	07	32	23	17	08	15	23	15
20	C		08	56	23	12	08	43	23	13	08	29	23	14	09	12	23	11
21	D		09	54	23	08	09	40	23	09	09	26	23	10	10	09	23	07
22	E		10	51	23	03	10	37	23	04	10	23	23	06	11	06	23	02
23	F		11	48	22	58	11	34	23	00	11	20	23	01	12	04	22	57
24	G	*John Baptist.*	12	45	22	53	12	31	22	54	12	17	22	56	13	01	22	52
25	A		13	42	22	48	13	28	22	49	13	15	22	50	13	58	22	46
26	B		14	39	22	41	14	26	22	43	14	12	22	44	14	55	22	40
27	C		15	37	22	35	15	23	22	37	15	09	22	38	15	52	22	33
28	D		16	34	22	28	16	20	22	30	16	06	22	32	16	49	22	26
29	E	27° 17′ N.	17	31	22	21	17	17	22	23	17	03	22	25	17	47	22	19
30	F	Swans bill.	18	28	22	13	18	14	22	15	18	00	22	17	18	44	22	11

Week Dayes.	Month Dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669.		Second Year 1670.		Third Year, 1671.		Leap Year, 1672.	
			⊙ pla.	⊙ dec	⊙ pla.	⊙ dec	⊙ pla.	⊙ dec	⊙ pla.	⊙ dec
			D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
			♋	North	♋	North	♋	North	♋	North
1	G		19 25	22 05	19 11	22 07	18 58	22 09	19 41	22 03
2	A		20 22	21 57	20 09	21 59	19 55	22 01	20 38	21 55
3	B	(35° 27′ S.	21 20	21 48	21 06	21 50	20 52	21 53	21 35	21 46
4	C	Sagit. thigh,	22 17	21 39	22 03	21 41	21 49	21 44	22 33	21 37
5	D	and Vulturs	23 14	21 30	32 00	21 32	22 46	21 34	23 30	21 27
6	E	heart, 8°2′N	24 11	21 20	23 58	21 22	23 44	21 25	24 27	21 18
7	F		25 09	21 10	24 55	21 12	24 41	21 15	25 24	21 07
8	G		26 06	20 59	25 52	21 02	25 38	21 04	26 22	20 56
9	A		27 03	20 48	26 49	20 51	26 35	20 53	27 19	20 45
10	B		28 00	20 37	27 47	20 40	27 32	20 42	28 16	20 34
11	C		28 58	20 25	28 44	20 28	28 30	20 31	29 13	20 22
12	D		29 55	20 13	29 41	20 16	29 27	20 19	♌ 11	20 10
13	E	Sol in Leo.	♌ 52	20 01	♌ 38	20 04	♌ 24	20 07	01 08	19 57
14	F		01 50	19 48	01 36	19 51	01 22	19 54	02 05	19 45
15	G		02 47	19 35	02 33	19 38	02 19	19 42	03 03	19 32
16	A		03 44	19 22	03 20	19 25	03 17	19 28	04 00	19 18
17	B	Swans tail,	04 42	19 08	04 28	19 12	04 14	19 15	04 57	19 40
18	C	44° 06′ N.	05 39	18 54	05 25	18 58	05 11	19 01	05 55	18 50
19	D	Dog dayes	06 36	18 40	06 23	18 44	06 09	18 47	06 52	18 36
20	E	begin.	07 34	18 25	07 20	18 29	07 06	18 33	07 50	18 21
21	F		08 31	18 11	08 17	18 14	08 04	18 18	08 47	18 07
22	G		09 29	17 56	09 15	17 59	09 01	18 03	09 44	17 51
23	A		10 26	17 40	10 12	17 44	09 58	17 48	10 42	17 36
24	B		11 24	17 24	11 10	17 28	10 56	17 32	11 39	17 20
25	C	*James Apost.*	12 21	17 08	12 07	17 12	11 53	17 16	12 37	17 04
26	D		13 20	16 52	13 05	16 55	12 51	17 00	13 34	16 47
27	E		14 16	16 35	14 02	16 39	13 48	16 43	14 32	16 31
28	F		15 14	16 19	15 00	16 23	14 46	16 27	15 30	16 14
29	G		16 11	16 01	15 57	16 06	15 44	16 10	16 27	15 57
30	A		17 09	15 44	16 55	15 48	16 41	15 53	17 25	15 39
31	B		18 07	15 27	17 53	15 31	17 39	15 35	18 22	15 22

Week Dayes.	Month Dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669. ⊙ pla.	First Year, 1669. ⊙ dec	Second Year 1670. ⊙ pla.	Second Year 1670. ⊙ dec	Third Year, 1671. ⊙ pla.	Third Year, 1671. ⊙ dec	Leap Year, 1672. ⊙ pla.	Leap Year, 1672. ⊙ dec
			D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
			♌	North	♌	North	♌	North	♌	North
1	C	(8° 24′ N.	19 04	15 09	18 50	15 30	18 36	15 17	19 20	15 04
2	D	Peg. Mouth.	20 02	14 50	19 48	14 55	19 34	14 59	20 18	14 45
3	E	2d bright *	21 00	14 32	20 46	14 37	20 42	14 31	21 15	14 27
4	F	Capr. Tail,	21 57	14 13	21 43	14 18	21 29	14 23	22 13	14 08
5	G	18° 02′ S.	22 55	13 55	22 41	13 59	22 27	14 04	23 11	13 49
6	A		23 53	13 36	23 39	13 40	23 25	13 45	24 09	13 30
7	B		24 51	13 16	24 37	13 21	24 23	13 26	25 06	13 11
8	C		25 48	12 57	25 34	13 02	25 20	13 06	26 04	12 52
9	D		26 46	12 37	26 32	12 42	26 18	12 47	27 02	12 32
10	E		27 44	12 17	27 30	12 22	27 16	12 27	28 00	12 12
11	F		28 42	11 57	28 28	12 02	28 14	12 07	28 58	11 52
12	G		29 40	11 37	29 26	11 42	29 12	11 47	29 56	11 31
13	A		♍ 38	11 17	♍ 24	11 22	♍ 10	11 27	♍ 54	11 11
14	B		01 36	10 56	01 22	11 01	01 08	11 06	01 52	10 50
15	C		02 34	10 35	02 20	10 40	02 06	10 45	02 50	10 29
16	D		03 32	10 14	03 18	10 19	03 04	10 24	03 48	10 08
17	E		04 30	09 53	04 16	09 58	04 02	10 03	04 46	09 47
18	F		05 28	09 32	05 14	09 37	05 00	09 42	05 44	09 26
19	G		06 26	09 10	06 12	09 16	05 58	09 21	06 42	09 04
20	A	(31° 20′ S	07 24	08 49	07 10	08 54	06 56	08 59	07 40	08 43
21	B	Fomahant.	08 23	08 27	08 08	08 32	07 54	08 38	08 38	08 21
22	C	(26° 15′ N	09 21	08 05	09 07	08 10	08 53	08 16	09 37	07 49
23	D	Peg, sholder.	10 19	07 43	10 05	07 48	09 51	07 54	10 35	07 36
24	E	*Bartholom.*	11 17	07 21	11 03	07 26	10 49	07 32	11 33	07 36
25	F		12 15	06 59	12 01	07 04	11 47	07 10	12 31	06 53
26	G		13 14	06 36	13 00	06 42	12 46	06 47	13 30	06 30
27	A		14 12	06 14	13 58	06 19	13 44	06 25	14 28	06 08
28	B	Dog dayes	15 11	05 51	14 56	05 57	14 42	06 02	15 26	05 45
29	C	end.	16 09	05 29	15 55	05 34	15 41	05 40	16 25	05 23
30	D		17 07	05 06	16 53	05 11	16 39	05 17	17 23	05 00
31	E		18 06	04 43	17 52	04 49	17 38	04 54	18 22	05 37

September hath XXX dayes.

Month dayes.	Week Dayes	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669.		Second Year 1670.		Third Year, 1671.		Leap Year, 1672.	
			☉ pla.	☉ dec	☉ pla.	☉ dec	☉ pla.	☉ dec	☉ pla.	☉ dec
			D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
			♍	North	♍	North	♍	North	♍	North
1	F	(by fire, 66	19 04	04 20	18 50	04 26	18 36	04 31	19 20	04 14
2	G	*Lo.* destroy'd	20 03	03 57	19 49	04 03	19 35	04 08	20 91	03 51
3	A	*Oli. Cromwel*	21 02	03 34	20 47	03 40	20 37	03 45	21 18	03 28
4	B	died, 1658.	22 00	03 11	21 46	03 16	21 32	03 22	22 16	03 04
5	C		22 59	02 48	22 45	02 53	22 30	02 59	23 15	02 41
6	D		23 57	02 24	23 43	02 30	23 29	02 36	24 13	02 18
7	E	*Nat. Eliz.*	24 56	02 01	24 42	02 07	24 28	02 12	25 12	01 55
8	F	*Nat. Mary.*	25 51	01 38	25 41	01 43	25 26	01 49	26 11	01 31
9	G	(27° 14′ N	26 54	01 14	26 39	01 20	26 25	01 26	27 10	01 08
10	A	Cap. Andro.	27 53	00 51	27 38	00 57	27 24	01 02	28 09	00 44
11	B	Cassi. chair.	28 51	00 27	28 37	00 33	28 23	00 39	29 07	00 21
12	C	57° 18′ N.	29 50	00 04	29 36	00 10	29 22	00 15	♎ 06	So 30
13	D	Sol in Libra	♎ 49	So 20	♎ 35	So 14	♎ 21	So 08	01 05	00 26
14	E		01 48	00 43	01 34	00 37	01 20	00 32	02 04	00 50
15	F		02 47	01 07	02 33	01 01	02 19	00 55	03 03	01 13
16	G		03 46	01 30	03 32	01 24	03 18	01 19	04 02	01 37
17	A		04 45	01 54	04 31	01 48	04 17	01 42	05 01	02 00
18	B		05 44	02 17	05 30	02 11	05 16	02 06	06 00	02 24
19	C		06 43	02 41	06 29	02 35	06 15	02 29	07 00	02 47
20	D	Whales tail.	07 43	03 04	07 28	02 58	07 14	02 53	07 59	03 10
21	E	19° 15′ S.	08 42	03 27	08 27	03 22	08 13	03 16	08 58	03 34
22	F	Pole star,	09 41	03 51	09 27	03 45	09 12	03 39	09 57	03 57
23	G	87° 30′ N.	10 40	04 14	10 26	04 08	10 12	04 03	10 56	04 20
24	A		11 40	04 37	11 25	04 32	11 11	04 26	11 56	04 44
25	B		12 38	05 01	12 25	04 55	12 10	04 49	12 55	05 07
26	C	South in Andromedas gir.	13 38	05 24	13 24	05 18	13 10	05 13	13 55	05 30
27	D		14 38	05 47	14 23	05 41	14 09	05 36	14 54	05 53
28	E	33° 52′ N.	15 32	06 10	15 23	06 04	15 08	05 59	15 35	06 14
29	F	*Michal Ar.*	16 37	06 33	16 22	06 27	16 08	06 22	16 53	06 39
30	G		17 36	06 56	17 22	06 50	17 07	06 45	17 52	07 02

Month dayes.	Week dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year 1669.				Second Year 1670.				Third Year 1671.				Leap Year 1672.			
			☉ Pla.		☽ dec.		☉ pla.		☽ dec		☉ pla.		☉ dec		☉ pla.		☉ dec	
			D	M.	D	M.	D	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
			♎		South.		♎		South.		♎		South.		♎		South.	
1	A		19	36	07	18	18	21	07	13	18	07	07	07	18	52	07	25
2	B		20	35	07	41	19	29	07	35	19	06	07	30	19	52	07	47
3	C	Edge Hill	20	35	08	03	20	21	07	58	20	06	07	53	20	51	08	10
4	D	Battel, 1642	21	35	08	26	21	20	08	21	21	06	08	15	21	51	08	32
5	E		22	34	08	48	22	20	08	43	22	05	08	37	22	51	08	54
6	F		23	34	09	10	23	20	09	05	23	05	09	00	23	50	09	16
7	G	(19° 09′ N.	24	34	09	32	24	19	09	27	24	05	09	22	24	50	09	38
8	A	17° 38′ N.	25	34	09	54	25	19	09	49	25	05	09	44	25	50	10	00
9	B	N: and S. in	26	33	10	16	26	19	10	11	26	04	10	06	26	50	10	22
10	C	the R. horn.	27	33	10	38	27	19	10	33	27	04	10	27	27	50	10	44
11	D	(21° 51′ N.	28	33	10	59	28	19	10	54	28	04	10	49	28	50	11	05
12	E	Rams head,	29	33	11	21	29	19	11	15	29	04	11	00	29	49	11	26
13	F	Sol in Scorp	m	33	11	42	m	19	11	37	m	04	11	31	m	49	11	47
14	G		01	33	12	03	01	19	11	58	01	04	11	52	01	49	12	08
15	A		02	33	12	23	02	19	12	18	02	04	12	13	02	49	12	29
16	B		03	33	12	44	03	19	12	39	03	04	12	34	03	50	12	49
17	C		04	33	13	04	04	19	12	59	04	04	12	54	04	50	13	10
18	D		05	33	13	24	05	19	13	20	05	04	13	15	05	50	13	30
19	E		06	34	13	44	06	19	13	40	06	04	13	35	06	50	13	50
20	F		07	34	14	04	07	19	13	59	07	05	13	55	07	50	14	09
21	G		08	34	14	24	08	19	14	19	08	05	14	14	08	50	14	29
22	A		09	34	14	43	09	20	14	38	09	05	14	33	09	51	14	48
23	B		10	35	15	02	10	20	14	57	10	05	14	53	10	51	15	07
24	C		11	35	15	21	11	20	15	16	11	06	15	12	11	51	15	26
25	D		12	35	15	39	12	21	15	35	12	06	15	30	12	52	15	44
26	E		13	36	15	58	13	21	15	53	13	06	15	49	13	52	16	02
27	F	Whales jaw	14	36	16	16	14	21	16	11	14	07	16	07	14	52	16	20
28	G	02° 44′ N.	15	36	16	33	15	22	16	29	15	06	16	24	15	53	16	38
29	A	*Sim. & Jude.*	16	37	16	51	16	22	16	47	16	08	16	42	16	53	16	55
30	B	Perseus side	17	37	17	08	17	23	17	40	17	08	17	00	17	54	17	12
31	C	48° 33′ N.	18	38	17	25	18	23	17	21	18	09	17	17	18	54	17	20

November *hath* XXX dayes.

Month dayes.	Week Dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year, 1669.		Second Year 1670.		Third Year, 1671.		Leap Year, 1672.	
			☉ pla.	☉ dec	☉ pla.	☉ dec	☉ pla.	☉ dec	☉ pla.	☉ dec
			D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
			m	South.	m	South.	m	South.	m	South.
1	D		19 38	17 42	19 23	17 37	19 09	17 33	19 55	17 46
2	E		20 39	17 58	20 24	17 54	20 10	17 50	20 56	18 02
3	F	Long Parl.	21 40	18 14	21 25	18 10	21 10	18 06	21 56	18 18
4	G	began, 1640	22 40	18 29	22 26	18 26	22 11	18 22	22 57	18 33
5	A	*Powder Plot.*	23 41	18 44	23 26	18 41	23 11	18 37	23 57	18 49
6	B		24 42	18 59	24 27	18 56	24 12	18 52	24 58	19 03
7	C	Perseus foot	25 42	19 14	25 28	19 11	25 13	19 07	25 59	19 18
8	D	30° 52′ N.	26 43	19 28	26 28	19 25	26 14	19 21	27 00	19 32
9	E		27 44	19 42	27 29	19 39	27 14	19 36	28 00	19 46
10	F		28 45	19 56	28 30	19 53	28 15	19 49	29 01	19 59
11	G		29 45	20 09	29 31	20 06	29 16	20 03	♐ 02	20 13
12	A	Sol in Sagit.	♐ 46	20 22	♐ 31	20 19	♐ 16	20 16	01 03	20 25
13	B		01 47	20 34	01 32	20 31	01 18	20 28	02 04	20 38
14	C		02 48	20 46	02 33	20 43	02 18	20 40	03 04	20 50
15	D		03 49	20 58	03 34	20 55	03 19	20 52	04 05	21 01
16	E		04 50	21 09	04 35	21 07	04 20	21 04	05 06	21 12
17	F		05 51	21 20	05 36	21 18	05 21	21 15	06 07	21 23
18	G	Bulls eye,	06 52	21 31	06 37	21 28	06 22	21 26	07 08	21 33
19	A	15° 47′ N.	07 53	21 41	07 38	21 38	07 23	21 36	08 09	21 43
20	B		08 54	21 50	08 39	21 48	08 24	21 46	09 10	21 53
21	C		09 55	22 00	09 40	21 57	09 25	21 55	10 11	22 02
22	D		10 56	22 08	10 41	22 06	10 26	22 04	11 12	22 11
23	E		11 57	22 17	11 42	22 15	11 27	22 13	12 13	22 19
24	F		12 58	22 25	12 43	22 23	12 28	22 21	13 14	22 27
25	G	The Goat,	13 59	22 32	13 44	22 30	13 29	22 29	14 15	22 34
26	A	45° 37′ N.	15 00	22 39	14 45	22 38	14 30	22 36	15 16	22 41
27	B	Orions foot,	16 01	22 46	15 46	22 44	15 31	22 43	16 18	22 48
28	C	08° 33′ S.	17 02	22 52	16 47	22 51	16 32	22 49	17 19	22 54
29	D	Orions r shol.	18 03	22 58	17 48	22 56	17 33	22 55	18 20	22 59
30	E	06° 00′ N.	19 04	23 03	18 49	23 02	18 35	23 00	19 21	23 04

December hath XXXI dayes.

Month dayes.	Week dayes.	Remarkable dayes, and the Southing of Stars at Midnight.	First Year 1669. ☉ Pla.	First Year 1669. ☉ dec.	Second Year 1670. ☉ pla.	Second Year 1670. ☉ dec	Third Year 1671. ☉ pla.	Third Year 1671. ☉ dec	Leap Year 1672. ☉ pla.	Leap Year 1672. ☉ dec
			D M	D M	D M	D M	D. M.	D. M.	D. M.	D. M.
			♐	South.	♐	South.	♐	South.	♐	South.
1	F	First in O-	20 05	23 08	19 51	23 07	19 36	23 05	20 22	23 09
2	G	rions girdle	21 07	23 12	20 52	23 11	20 37	23 10	21 23	23 13
3	A	00° 35′ S.	22 08	23 16	21 53	23 15	21 38	23 14	22 24	23 17
4	B	(44° 52′ N.	23 09	23 29	22 54	23 19	22 39	23 18	23 26	23 20
5	C	Wag. shold:	24 10	23 22	23 55	23 22	23 40	23 21	24 27	23 23
6	D	Orions right	25 11	23 25	24 56	13 24	24 42	23 24	25 28	23 25
7	E	shoulder,	26 13	23 27	25 58	23 26	25 43	13 26	26 29	23 27
8	F	07° 58′ N.	27 14	23 28	26 59	23 28	26 44	23 28	27 30	23 29
9	G		28 15	23 29	28 00	23 29	27 45	23 29	28 31	23 29
10	A		29 16	23 30	29 01	23 30	28 46	23 30	29 33	23 30
11	B	Sol in Capr:	♑ 17	23 30	♑ 03	23 30	29 48	23 30	♑ 34	23 30
12	C		01 19	23 30	01 04	23 30	♑ 49	23 30	01 35	23 29
13	D		02 20	23 29	02 05	23 29	01 50	23 29	02 36	23 28
14	E	Pollux foot,	03 21	23 28	03 06	23 28	02 52	23 28	03 38	23 27
15	F	16° 39′ N.	04 22	23 26	04 07	23 26	03 53	23 27	04 39	23 25
16	G		05 24	23 23	05 09	23 24	04 54	23 25	05 40	23 23
17	A		06 25	23 21	06 10	23 21	05 55	23 22	06 41	23 20
18	B		07 26	23 17	07 11	23 18	06 56	23 19	07 43	23 16
19	C		08 27	23 14	68 12	23 15	07 58	23 16	08 44	23 13
20	D		09 29	23 10	09 14	23 11	08 59	23 12	09 45	23 08
21	E	*Thomas.*	10 30	23 05	10 15	23 06	10 00	23 07	10 46	23 04
22	F		11 21	23 00	11 16	23 01	11 01	23 02	11 48	22 58
23	G		12 32	22 54	12 17	22 56	12 03	22 57	12 49	22 53
24	A		13 33	22 48	13 19	22 50	13 04	22 51	13 50	22 47
25	B	*Nat. Christ.*	14 35	22 42	14 20	12 44	14 05	22 45	14 51	22 40
26	C	*Stephen.*	15 36	22 35	15 21	22 37	15 06	22 39	15 53	22 33
27	D	*John Evang.*	16 37	22 28	16 22	22 30	16 07	22 31	16 54	22 26
28	E	*Innocents.*	17 38	22 20	17 23	22 22	17 09	22 24	17 55	22 18
29	F	(6° 5′ N.	18 40	22 12	18 25	22 14	18 10	22 16	18 56	22 09
30	G	Little Dog.	19 41	22 03	19 26	22 05	19 11	22 07	19 57	22 01
31	A		20 42	21 54	20 27	21 56	20 12	21 57	20 59	21 52

An

An Explanation of the precedent Kalendar.

IN each Page there are eleven Colums, the first sheweth the day of the Month; the second, the dayes of the Week, expressed by the week day Letters, as in the year 1669. in the Month of *May*, you will find to be B for Saturday, and C for Sunday, which is the Dominical Letter for that year, (as you see in the page before the Kalendar) The third Column, sheweth some remarkable dayes, and the Southing of several Stars at midnight, with their Declinations from the Equinoctial, as in the aforesaid Month you will find against the third day, there stands *Lucida Corona*, which sheweth, that the said Star comes to the Meridian the third day, at twelve of the clock at midnight. The fourth Column, sheweth the place of the Sun for the first year after Leap year, (according to Mr. *Streets* Tables, in the Appendix to *Astro. Car.*) as against the forementioned day you will find the Sun to be in 23° 05′ in *Taurus*. The fifth Column, sheweth the Declination of the Sun, for the first year after Leap year, as against the third day aforesaid you will find the Suns Declination to be 18° 35′; and according to the same rule and reason, the other six Columns are to be used, as against the said third day of *May* you will find in the sixth Column, in the second year after Leap year, that the Suns place is 22° 51′ in *Taurus*: And in the seventh Column, the Suns Declination to be 18° 32′; And in the eighth Column, and in the third year after Leap year, the Suns place 22° 37′ in *Taurus*; and in the ninte Column, the Declination of the Sun is 18° 28′: And in the tenth Column, and in the Leap year, the Suns place is 23° 20′ in *Taurus*; and in the eleventh Column the Suns Declinations is 18° 39′, against the aforesaid third of *May*.

A Table of the Variation of the Sun's Declination, to be applyed for Years to come, according to the Titles on the right hand, but for years past contrarily.

Years.	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	
Mon. Dayes.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
January, 1	0	1	01	01	01	02	02	02	02	03	03	03	04	04	04	Nor.
11	0	1	01	01	02	02	03	03	04	04	04	05	05	05	06	
21	0	1	01	02	02	03	03	04	04	05	05	06	06	07	07	
February, 1	1	1	02	02	03	03	04	05	05	06	06	07	08	08	09	
11	1	1	02	03	03	04	05	05	06	06	07	08	08	09	10	
21	1	1	02	03	03	04	05	05	06	07	08	08	09	10	10	
March, 1	1	1	02	03	04	04	05	06	06	07	08	08	09	10	11	
11	1	1	02	03	04	04	05	06	06	07	08	09	09	10	11	
21	1	1	02	03	04	04	05	06	06	07	08	08	09	10	11	
April, 1	1	1	02	03	03	04	05	05	06	07	07	08	09	10	10	
11	1	1	02	03	03	04	04	05	06	06	07	08	08	09	10	
21	1	1	02	02	03	03	04	05	05	06	06	07	07	08	08	
May, 1	0	1	01	02	02	03	03	04	04	05	05	06	06	07	07	
11	0	1	01	02	02	02	03	03	03	04	04	05	05	05	06	
21	0	1	01	01	01	02	02	02	02	03	03	03	03	04	04	
June, 1	0	0	00	01	01	01	01	01	01	01	01	02	02	02	02	
11	0	0	00	00	00	00	00	00	00	00	00	00	00	00	00	Sout.
21	0	0	00	01	01	01	01	01	01	01	01	02	02	02	02	
July, 1	0	1	01	01	01	02	02	02	02	03	03	03	03	04	04	
11	0	1	01	02	02	02	03	03	03	04	04	05	05	05	06	
21	0	1	01	02	02	03	03	04	04	05	05	06	06	07	07	
August, 1	1	1	02	02	03	03	04	05	05	06	06	07	07	08	09	
11	1	1	02	03	03	04	04	05	06	06	07	08	08	09	10	
21	1	1	02	03	03	04	05	05	06	07	08	08	09	10	10	
September, 1	1	1	02	03	04	04	05	06	06	07	08	09	09	10	11	
11	1	1	02	03	04	04	05	06	06	07	08	09	09	10	11	
21	1	1	02	03	04	04	05	06	06	07	08	09	09	10	11	
October, 1	1	1	02	03	03	04	05	05	06	07	08	08	09	10	10	
11	1	1	02	03	03	04	04	05	06	06	07	08	08	09	10	
21	1	1	02	02	03	03	04	05	05	06	06	07	07	08	09	
November, 1	0	1	01	02	02	03	03	04	04	05	05	06	06	07	07	
11	0	1	01	02	02	02	03	03	03	04	04	05	05	05	06	
21	0	1	01	01	01	02	02	02	02	03	03	03	03	04	04	
December, 1	0	0	00	01	01	01	01	01	01	01	01	02	02	02	02	
11	0	0	00	00	00	00	00	00	00	00	00	00	00	00	00	Nor.
21	0	0	00	01	01	01	01	01	01	01	01	02	02	02	02	

A Table of the Variation of the Sun's Declination in Hours.

Hours from the Meridian of London.

Diurnal variat minutes.	1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m	11 m	12 m
2	0	0	0	0	0	0	1	1	1	01	01	01
3	0	0	0	0	1	1	1	1	1	01	01	01
4	0	0	0	1	1	1	1	1	1	02	02	02
5	0	0	1	1	1	1	1	2	2	02	02	02
6	0	0	1	1	1	1	2	2	2	02	03	03
7	0	1	1	1	1	2	2	1	3	03	03	03
8	0	1	1	1	2	2	2	3	3	03	04	04
9	0	1	1	1	2	2	3	3	3	04	04	04
10	0	1	1	2	2	2	3	3	4	04	05	05
11	0	1	1	2	2	3	3	4	4	05	05	05
12	0	1	1	2	2	3	3	4	4	05	05	06
13	1	1	2	2	3	3	4	4	5	05	06	06
14	1	1	2	2	3	3	4	5	5	06	06	07
15	1	1	2	2	3	4	4	5	6	06	07	07
16	1	1	2	3	3	4	5	5	6	07	07	08
17	1	1	2	3	4	4	5	6	6	07	08	08
18	1	1	2	3	4	4	5	6	7	07	08	09
19	1	2	2	3	4	5	6	6	7	08	09	09
20	1	2	2	3	4	5	6	6	7	08	09	10
21	1	2	3	3	4	5	6	7	8	09	10	10
22	1	2	3	4	5	5	6	7	8	09	10	11
23	1	2	3	4	5	6	7	8	9	10	11	11
24	1	2	3	4	5	6	7	8	9	10	11	12

Examples of the uſe of the foregoing Tables, *For the Suns Declination for years to come*, &c.

Example, 1.

Anno 1695, *May* the firſt, The Declination of the Sun is required.

Firſt, From the year 1695. I deduct all the hundreds and ſcores, that is 1680. and the reſidue 15, I divide by 4, the laſt remainer 3, ſhews it is *the third after Leap Year*. Therefore,

Secondly, In the Calendar for four years, I look for *third after Leap year*, and do find it anſwer to 1671. In which year, on the firſt day of *May*, the *Declination* of the Sun is 17° 58′ North.

Thirdly, Then out of 1695, I ſubſtract 1671, and with the reſidue 24, I enter the *Table of the Variation of the Suns Declination for years*, &c. where under 24 years, in the head of the Table, and againſt *May* the firſt, on the left hand I find the *Variation* 3′ North. But the aforefound *Declination* was alſo North, therefore to the ſaid *Declination* 17° 58′, I add the *Variation* 3′, and the ſum is 18° 1′ North, the true *Declination* of the Sun, *Anno* 1695. *May* the firſt, in the *Meridian of London*, as was required.

Example, 2.

Anno 1728, *September* the firſt, I would know the *Suns Declination*; And from 1728, rejecting the *hundreds and ſcores*, I divide the reſidue, which is 8 by 4, the remainer 0, ſhews it is *Leap year*, under which Title I find 1672, in which, on the firſt day of *September*, the *Declination* of the Sun is 4° 14′ North.

Then from 1728, I ſubſtract 1672, reſts 56 years, under which, and againſt *September*, 1. (in the *Table of Variation in years*) I find the *Variation* 10′ South; which ſubſtracted from the aforefound *Declination* 4° 14′ North, reſts 4° 4′ North, the true *Declination* of the Sun.

And here note, that when the *Declination* and *Variation* are both North, or both South, their ſum is the true *Declination*; but if the one be North, and the other South, it's their difference.

For

For the Declination of the Sun, when he is out of the Meridian of London.

Example, 1.

Anno 1672. *April* the 11th day, at 6 of the Clock afternoon; I would know the Suns Declination?

The 11th day at Noon, I find it in the Calendar 12° 14′ North, and the 12th day 12° 34′ therefore ſubſtracting the leſſer Declination 12° 14′ ont of the greater 12° 34′, the reſidue 20′ is the daily increaſe.

Then in the *Table of Variation in hours, &c.* under 6 hours in the head, and againſt 20′ on the left hand, I find 5′ the proportional part, which (becauſe the hour was afternoon, and the Declination increaſing) added to the aforefound 12° 14′, the ſum is 12° 19′ North, the Declination required.

Example, 2.

For the Declination of the Sun, *Anno* 1672. *October* the 28th day, at 8 in the morning, that is 4 hours reckoned backward from Noon.

In the Calendar, the Declination on the 28*th* day of *October*, that year is 16° 38′, and on the 27*th* day, 16° 20′ South; the difference is 18′, againſt which, and under 4 hours, in the Table of *Variation in Hours*, &c. I find the proportional part 3′, which (in this Example) ſubſtracted from 16° 38′, there remaineth 16° 35′ South, the Declination ſought.

And thus may the true Declination of Sol be eaſily found at all times, and in all *Meridians*, of which, I ſuppoſe, here will need no more Examples.

The Suns Horizontal Parrallel is only 15 ſeconds, therefore the Parrallax need not be applyed at all.

Alſo the Suns refraction is demonſtratively equal to that of the fixt Stars, which latter is by the obſervation of Tythe Brache in the Horizon 30 minuits, and in the 20 deg. of Alt. 0. ſee the Particulars in *Aſt. Car.* and in *Wings, Exam. Examinatum.*

CHAP. X.

Containing the Description and Use of the most necessary Instruments in the Art of Navigation.

The Original Discovery and Invention of the Marriners Compass, and the Excellency thereof.

THis marvellous and most useful Instrument, called the *Marrinars Compass*, being justly ranked amongst the greatest Wonders that this World affords, and deserves well to be understood by all that are Students and Practitioners in the Art of Navigation; for without the help thereof, it were impossible to trace out the unbeaten Paths of the Ocean; for the procuring Trade and Traffique beyond the Seas, to remote parts of the World, and by the means thereof, the Glorious Gospel hath been transmitted into the most dark corners of the Earth.

As to the Original Inventer hereof, Modern Historians do somewhat vary; some attribute the Invention thereof to one *John Goia*, (or *Flavia Goia*, as others stile him) of *Amalphi* in *Campania*, in the Kingdom of *Naples*, who onely accomodated the Superfecies thereof with eight Points, that is four Cardinal, and four Collateral; and so left the improvement of this Invention, to be attempted by Posterity. But *Pilidore Virgil*, an *Italian*, who searched most diligently for such Inventions, could never hear of this Opinion, as he confesseth in the latter end of his third Book, *De Inventoribus Rerum*. But some do seem to assert, that the finding thereof is more modern, and hardly to be proved that it hath been in use in these parts of the World full three-hundred years. Others do intitle the invention thereof to the people

of

of *China*. Doctor *Gilbert* in his Book *De Magnete*, aſſerts, that *Paulus Venetus* tranſported it firſt into *Italy*, in the year 1260, having learned it from the *Chineſes*. And *Ludi Vertomannus* affirms that when he was in the *East Indies*, about the year 1500. he ſaw the Pilot of his Ship direct his courſe by a Compaſs, faſhioned and framed at thoſe which now are commonly uſed.

And Mr. *Barlow*, in his Book intituled, *The Navigators Supply*, Anno 1597. relateth a ſtory of two *East Indians*, that he had perſonal conference with, (one of them which was of *Mamilia*, in the Iſle of *Luzon*; the other of *Miaco* of *Japan*) who declared, that inſtead of our Compaſs, they uſe a Magnetical Needle of ſix inches and longer, upon a Pin, in a diſh of white *China* Earth filled with Water, in the bottom whereof they have two croſs Lines, for the four principal Winds; the reſt of the Deviſions being left to the skill of their Pilots. Alſo he there relates, that the *Portugals* in their firſt diſcoveries of the *East Indies*, they got a Pilot of *Melinde*, that brought them from thence in thirty three dayes, within the ſight of *Calecute*; and even then they had the uſe of the Compaſs, the Card, and the ſounding Line.

Philander in his Annotations upon *Vitruvius*, ſheweth, that ſome men deem'd it not a new, but an old Invention, and took it to be a Nautical Inſtrument, which is called by *Plautus* in *Trinummo*, and *Mercatore*, by the name of *Verſoria*. But this *Adrian Turnebus* in no caſe will allow affirming it rather to be a kind of Tackle, wherewith they turned their Sail, which is ſuppoſed to be the Bowlin, that is now commonly uſed in theſe dayes. But let the Invention be attributed to whom it will, this is manifeſtly known to have received its abſolute perfection in theſe parts of the World, but more particularly the compleating of this Invention is due to the people of *Antwerp* and *Bruges*; and alſo to our own Nation, by annexing to the Compaſs twenty four other ſubordinate Winds or Points: and alſo on the Limb thereof 360 degrees, which are the degrees of the Azimuth, (by which are found the Suns Maguettical Amplitude and Azimuth,) and are numbred from North and South, toward the East and Weſt, with 10, 20, 30, *&c.* So that it appeareth that every Point containeth 11° 15′. Upon the North Point thereof, is put a Flowerdeluce, as a note of deſtinction to deſtinguiſh it from the reſt of the Points: And ſometimes it is ſuppoſed to be divided into twenty four equal parts or hours.

Before the invention of this Ingenious Artifice; men were directed

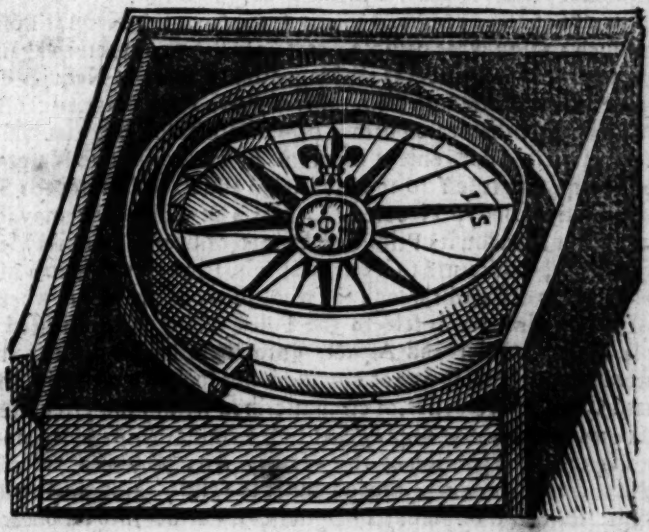
in

in their Voyages by certain Stars they took notice of, eſpecially the Pleiades, or ſeven Stars, by Charles his Wain, and the two Stars in the Tail of the little Bear, which were therefore called *Load-ſtars.* Alſo Travellers in the Deſarts of *Arabia*, and thoſe of *Tartaria*, were alwayes guided by ſome fixt Stars in the night time, to ſteere their Courſes in thoſe pathleſs, diſordered, and unhoſpitable wayes. So the Seamen were directed by the like Heavenly Guides, in the untractable Wilderneſs of Waters, and unbeaten Paths of the Ocean, before this excellent Artifice was diſcovered: But if the Sky happened to be ſullied with Miſts, and the Stars to be muffled with Clouds, then the moſt experienced Marriner was at a loſs, and was conſtrained to come to an Anchor, or to lie by, to wait the appearance of his Celeſtial Directors; and if you conſult *Pliny*, he will tell you alſo of the Inhabitants of *Taprobana*, (now called *Sumatra*) becauſe they could not behold the Pole-ſtar to Sail by, carried certain Birds to Sea, which they did often let fly. And as thoſe Birds by natural inſtinct applyed their flight alwayes to Land; ſo the Marriners directed their Courſe after them, *&c.*

To theſe and the like difficulties were men expoſed unto before the invention of this marvelous Inſtrument. But by this unparrallel'd piece of Art, Poſterity is ſecured with a noble Remedy, againſt this grand inconvenience, and a method diſcovered, as by an immediate Meſſenger from Heaven, to ſteer an infallible Courſe in the moſt gloomy nights, and tumultuous Seas, and through the Providence of the Almighty, be ſafely conducted to the deſired Port.

Yet this worthy Inſtrument is not ſo arrived to that abſolute perfection, by reaſon of that acquired vertue it receives from the *load-ſtone*; but that it requires ſome improvements and amendments, becauſe it doth not conform it ſelf to the true Meridian in all places; but varies and diſtorts it ſelf in ſome places more, and in ſome leſs, from the direct poſition, Configuration and Aſpect of the true North and South, which multiplies and enforces the Seamans deſtractions, and enwraps him oftentimes in difficult and dangerous Errors; but the whole Diſcourſe of the Variation, and of the probable conjectures of the Natural Cauſe thereof, is fully handled in that which follows. I thought it neceſſary (for method ſake) to ſubjoyn the Figure of the Marriners Compaſs.

The Figure of the Marriners COMPASS.



A Diſcourſe of the Variation of the Compaſs, and of the Natural Cauſe thereof.

THE Variation of the Compaſs, is an Angle intercepted between the Magnetical and the true Meridian, the Horizon determining its Quantity and Quality: Theſe Meridians ſometimes are coincident, and in ſuch places there can be no variation; ſometimes again they are different: and then that Hemyſphere wherein the Northern extremity of the Needle lies, denominates its Quality; for if it be to the Eaſtward, then is it called Eaſterly Variation, if to the Weſtward, then Weſterly.

And

And for the Reaſons of the natural cauſe of the Variation, I hope, firſt of all, that it will be granted (by the Judicious) that the great Globe of the Earth whereon we move, is a Magnetical Body; as daily experience doth manifeſtly prove, if you take but notice of the Univerſal Conformity of the Compaſs, to neer one and the ſame Poſition to the North and South Poles of the World, the which is thereunto commanded by the Magnetical and Diſponent Faculty of the great Magnet the Earth, by whoſe Magnettick Vigor, paſſing from her Meridional parts, to the Poles ſhe is held and ſuſtained in that Poſiture, and not to be removed by any force from her Natural Poſition; yet if ſuch a thing were poſſible, certainly ſhe would return again unto her former ſeat and place, as all Magnetical Bodies & Needles do, that receive virtue & ſtrength from the *load-ſtone*. For a Magnetical Body is ſtil'd, not only that which hath a power attractive, but that which being ſcituated in a convenient Medium, by an Intrinſique Natural propenſity diſpoſeth it ſelf to one invariable and fixed Reſidence: So that if a Magnetical Body, Needle or Compaſs be violently removed, yet would it not abandon its Primitive Points, or ſwerve from its Meridional Polarity, but return to its natural ſcituation: And ſuch a Magnetical vertue is diffuſed through the whole body of the Earth, whereby it conſtantly addreſſeth it ſelf to the Poles, being ſo conſtituted in its whole Frame, Order and Aſpect, unto theſe Points; that the Attractive Vigor thereof, is not confined nor locked up within its own inward Cells and Receſſes, or circumſcribed within the circumference of its own ſurface, but diſplay'd at indeterminate diſtances, notwithſtanding the interpoſition of the Water, Air, and all other circumjacent bodies whatſoever, though never ſo ſolid; through all which it doth excite, and tranſplant its Magnetical Vertue, into all bodies fitly qualified within and without it; and effecting this in an abſtruſe and indecernable way, the which we may ſee viſibly performed by the Load-ſtone: for theſe Efluviums penetrate all bodies, and attaque all objects capable of their vigorous and active excitation; as is apparently manifeſt in all Magnetical Needles and Compaſſes, having received ſtrength from the Load-ſtone; (but more eſpecially in the Inclinatory Needle) that the direction and ſcituation that they do then aſſume, is not abſolutely from its own natural propenſity to that poſition originally reſulting from themſelves; but is derivetive, and contracted from the powerful command of the Magnetick Eflux of the Earth, and by their mutual entwining and complication, carry away the Needle as their

their Captive, and place it according to her natural poſition. But ſeveral learned men, and great Philoſophers, are at a great conteſt about this matter; for *Grandamicus*, a learned French man, in his Magnetical Tractate, *De Immobilitate Terræ*, doth affirm, that the virtue of the Magnet, and all Magnetical bodies, is purely immaterial, and a bare ſimple quality, and that it proceeds intrinſecally from the proper form of the Load-ſtone, as he hath delivered in the third Chapter of the ſaid Book, page 48. The which Aſſertion of his, is much queſtioned by that learned and experimental Philoſopher, Dr. *Power*, in his Book of experimental Philoſophy, from page 157, to page 161, where there he doth affirm, That the Magnetical Effluviums, do not proceed intrinſecally from the Stone, but are certain extrinſecal Particles, which approaching to the Stone, and finding congruous Pores and Inlets therein are channel'd through it: And having acquired a motion thereby, do continue their current ſo far, till being repulſed by the Ambient Air, and they recoyl again, and return in a Vortical Motion, and ſo continue their revolution for ever, through the body of the Magnet; which he doth there endeavour to prove by ſeveral Arguments.

And for the further Demonſtration of this probable Truth, (that the cauſe of the Variation is clearly from the Magnatiſm of the Earth) I ſhall preſent an notable Experiment that may be performed by the Magnet.

Take a Vigorous Magnet, and let it be converted into a Spherical Body, and having found its Poles, delineate the ſame with Meridians, the Equinoxial and Parrallels; then take a ſmall Magnetical Needle on a Pin, and if you apply this Needle to the Equinoctial of the ſaid Stone, the Needle will lie parrallel to the Axis thereof, and if you move it toward either Pole, the Needle will immediately incline toward the ſaid Pole, according as you move it, until you come to the Pole, then will one part of the Needle point directly to the very Pole of the Stone.

But if this Spherical Magnet ſhall have a part of it excavated, as admit about the 45th Parrallel; then if you move the Needle about the Stone as before, as ſoon as it ſhall draw near to the limb of this Excavation, will in its courſe of moving, ſuddenly alter and incline to one of the ſollid ſides, not at all reſpecting the aforeſaid Poles: And this deflection is called, The Variation of the Needle; and the

greater will this Variation be, the nearer it approacheth to the Poles; for whereas before the Excavation, each side being a like potent, the Needle inclined according to his natural position, but meeting with this accident in nature (that is to say) the Excavation, it will convert it self to the more solid side, rejecting the imperfect and defective; and so much the more powerfully, by how much the defective part hath loſt of its magnetical vigorous ſubſtance.

And as it is with this little, ſo likewiſe with the greater Magnet, the Earth, whoſe ſolid magnetical parts, are great continents, the defective and Excavated, the deep and vaſt Chanel of the Sea; and therefore the cauſe of the Variation, may be the inequality of the Earth, variouſly diſpoſed, and differently mixed with the Sea; and all the different emiſſion of its ſtrength, and magnetical vigor, from the more eminent and gibbous, and from the hollow and excavated parts thereof; for the Needle naturally endeavours to conform unto the Meridian, but being deſtracted, is driven and diſtorted that way, where the greater and more powerful parts of the earth are ſeituated.

To this may be added, That the Variation proceedeth not onely from ſome eminent Terreſtial Knobs or Excreſſencies which appear like ſo many Wens upon the face of the Earth, as alſo from many Magnetical Veins of the Earth, collaterally reſpecting the Needle, but likewiſe from the different accumulation of the Earth, diſpoſed unto the Poles, lying under the Sea and Waters; which affect the Needle with a greater or leſſer variation, according to the vigor or impotency of theſe ſubterraneous Lines, or the intire or broken body of the Magnetical Fabrick under it; as it is obſervable from ſeveral Load-ſtones, placed at the bottom of any Water: for a Needle upon the ſurface will variouſly conform it ſelf, according to the vigor or imbecelity of the Load-ſtones under it.

The Globe of the Earth, is known to be very uneven and unequally mixed with many Materials, differing from a Magnetical quality, having great and ſtony Mountains, large Vallies, deep Seas, long and high Continents and Promontories, ſome with mighty ſcattered Rocks of Loadſtones, of Iron Mines, and other Magnetical Matter, &c.

And

And whereas it is manifestly apparent, that there is a certain Mutation or Alteration of the Variation; and in regard the Theory thereof is pretended to by some, I shall forbear to mention any thing of the probable Conjectures of the natural Cause thereof, but leave it to the discussion of time, and shall here present you with most of the publick Observations that have been made (of the Variation of the Compass) near the City of *London*, for near these hundreds years last past.

Mr. Burrows *his Observation of the Variation, made at* Lime-house, October *the* 16th, 1580.

Before Noon.				After Noon.						
Elevation of the Sun.		Variation of the Shadow, from the North of the Needle to the Eastward.		Elevation of the Sun.		Variation of the Shadow, from the North of the Needle to the Eastward.		Variation of the Needle from the Pole or Axis.		
Gr.	min.	Gr.	min.	Gr.	min.	Gr.	min.	Gr. min. sec.		
17	00	52	35	17	00	30	00	11	17	30
18	00	50	08	18	00	27	45	11	18	37
19	00	47	30	19	00	24	30	11	30	00
20	00	45	00	20	00	22	15	11	22	30
21	00	42	15	21	00	19	30	11	22	30
22	00	38	00	22	00	15	30	11	15	00
23	00	34	40	23	00	12	00	11	20	00
24	00	29	35	24	00	07	00	11	17	00
25	00	22	20	25	00	00	08	11	14	00

Mean Variation 11° 17′ 30″ from the North Eastward.

Mr. Gunter's *Observations, made at* Lime-house, June 13. Anno 1622. *Afternoon.*

Alti Sol	Azim. magn.	Azim. Sol.	Variation.	
Gr. min.	Gr. m.	Gr. m.	Gr. m.	
19 00	82 02	75 52	06 10	
18 05	80 50	74 44	06 06	
17 34	80 00	74 06	05 54	Variation, 06° 15′ Eastward.
17 00	79 15	73 20	05 55	
16 18	78 12	72 32	05 40	
16 00	77 50	72 10	05 40	
10 10	71 02	64 49	06 13	
09 52	70 12	64 25	05 47	

So that here it is Observed, that in the Intervale of the Observations made by Mr. *Burrows* and Mr. *Gunter*, in 42 years, the evident Diminution hath been 5 degrees.

Mr. Gillibrand's *Observations made at* Deptford, Anno 1634. June 12. before Noon.

Alti Sol vera.	Azim. Mag.	Azim. Sol.	Variation.
Gr. m.	Gr. m.	Gr. m.	Gr. m.
44 45	106 00	110 06	04 06
46 30	109 00	113 10	04 10
48 31	113 00	117 01	04 01
50 54	118 00	122 03	04 03
			03 55

In

In the Afternoon the same day.

Alti Sol vera.		Azim. Mag.		Azim. Sol.		Variation.	
Gr.	m.	Gr.	m.	Gr.	m.	Gr.	m.
44	37	114	00	109	53	04	07
40	48	108	00	103	50	04	10
38	46	105	00	100	48	04	12
36	43	102	00	097	56	04	04
34	32	099	00	095	00	04	00
32	10	096	00	091	55	04	05

The mean of which Observations is 04° 04′ Eastward.

Observations made by Mr. *Gillibrand* at *Pauls Cray* in *Kent*, *July* 4. 1634. Afternoon.

Vera alt Sol.		Azim. Mag.		Azim. Sol.		Variation.		
Gr.	m.	Gr.	m.	Gr.	m.	Gr.	m.	
40	55	111	30	107	30	04	00	
40	01	110	00	106	05	03	55	
39	41	109	30	105	34	03	56	
38	42	108	00	104	05	03	55	
35	32	103	30	99	32	03	58	The mean Variation is about 4 degrees eastward
34	49	102	30	98	32	03	58	
33	41	101	00	97	00	04	00	
32	57	100	00	96	02	03	58	
32	09	99	00	94	58	04	02	
31	25	98	00	94	00	04	00	
30	39	97	00	93	01	99	59	
29	29	95	30	91	31	03	59	
27	51	93	30	89	28	04	02	

So that here also it may be noted, that the sensible diminution of the Variation in 54 years, (from the time of Mr. *Burrows* Observations) is something more then seven degrees.

Obser-

Observations made by *John Seller*, at the *Hermitage* near *London*, with a Quadrant of 6 foot Radius, for the Altitude: and an Instrument of two foot Radius for the *Azimuth*, taken in the year, 1666. Lat, 51 deg. 32 min.

June 4. 1666. in the forenoon.

Vera alt Sol.		Azim. Mag.		Azim. Sol.		Variation.	
From the North part of the Merid.							
Gr.	m.	Gr.	m.	Gr.	m.	Gr.	m.
26	00	85	00	84	32	00	28
27	30	87	00	86	22	00	38

June 13. 1666. in the Afternoon.

Vera alt Sol.		Azim. Mag.		Azim. Sol.		Variation.	
From the North part of the Merid.							
Gr.	m.	Gr.	m.	Gr.	m.	Gr.	m.
08	30	62	00	62	26	00	26
08	15	61	30	62	06	00	36
07	45	60	45	61	24	00	36
07	15	60	00	60	44	00	44

June 14. 1666. in the Forenoon.

Vera alt Sol.		Azim. Mag.		Azim. Sol.		Variation.	
From the North part of the Merid.							
Gr.	m.	Gr.	m.	Gr.	m.	Gr.	m.
29	30	89	30	88	40	00	50
30	25	91	40	90	20	01	20
31	20	91	30	90	58	00	32
32	30	94	00	93	26	00	34
33	15						

The Mean of these Observations, is 41′ Westward.

The

The Description and Use of the Azimuth Compass.

This Compass doth derive its name from its Use, being principally to find the Magnettical Azimuth of the Sun, and is in several respects like unto another Compass, only with such necessary things added, and others omitted, that are most convenient for that purpose.

Upon the round Box, wherein are the Fly and Needle, is fastned a broad circle of Brass, the one half of the Limb thereof is divided into 90 degrees, numbred from the middle of the said divisions both wayes, with 10, 20, 30, *&c.* unto 45 degrees: Which degrees are also subdivided into minuits by Diagonal Lines, and by certain Concentrick Circles intersecting one another: but these Degrees are drawn from the opposite part of the Limb, whereon the Index moveth and cutteth those degrees in time of observation; and on this Index, is erected a sight, which for conveniency is to fall down with a Hing, and to set up upon occasion; and from the top of this Sight, down to the middle of the Index, is fastned a third or late string, to shew the shadow of the Sun, upon a Line that is drawn on the middle of the said Index.

And by this means of the placing the Index, upon the circumference, the degrees come to be as large again as they would be, if it moved upon the Center: the truth hereof is evidently demonstrated in the third Book of *Euclid. prop.* 20. *Theor.* 18.

This broad Circle is crossed at right Angles with two strings, and commonly from the terminations of these strings, are drawn four small black lines, on the inside the Box, for the rectifying the Instrument in time of observation, by the four lines that are also drawn at right Angles on the Superfecies of the Fly.

This Compass being thus fitted, is hung in very strong brass Rings and those also fastned into a strong square Wainscot Box fit for that purpose; which you may more plainly perceive in this following Figure.

The

The Figure of the Azimuth COMPASS.

The Use of the Azimuth Compass, in time of Observation.

First, You must rectifie the brass Limb on the edge of the Box, (by the Needle and Fly within the Box) according as the nature of the Observation doth require; for if the Observation be in the Forenoon, then you must put the Center of the Index upon the West point of the Fly

Card or Fly within the Box; and ſo that the four lines on the edge of the Card, and the four lines by the inſide of the Box, do alwayes concur.

The Inſtrument being thus rectified, turn the Index toward the Sun, until the ſhadow of the Hipotenuſal thread do fall directly into the very ſlit of the ſight that is on the Index, and alſo upon a ſtrait line that is in the middle of the Index; then at the ſame time will the inner edge of the Index cut the degree and minuits of the Suns Magnetical Azimuth, from the North or South part of the Meridian, being judiciouſly conſidered.

As for Example.

Suppoſe that the Inſtrument be rectified as before is ſhewed, for an obſervation in the forenoon, and that the Index ſhould cut juſt at 10 degrees upon the Limb, to the northward of the Eaſt part thereof, then is the Azimuth of the Sun 80 degrees from the North part of the Meridian, or elſe 100 degrees from the South part thereof. So likewiſe if the Index had cut 10 degrees to the Southwards of the Eaſt, then would the Azimuth be 80 degrees from the South, and an 100 from the North part of the Meridian.

And here alſo obſerve, that the Compaſs thus ſtanding in this poſition, and that the real Azimuth of the Sun be leſs then 45 Degrees from the South part of the Meridian, if you turn the Index toward the Sun, it will then go off the diviſions on the Limb, and there can be no uſe made thereof as it now ſtands.

Therefore to ſupply this defect, you muſt turn the Inſtrument juſt one quadrant, or one quarter of the Compaſs, (*viz.*) to place the Center of the Index on the North or South point of the Card, and then the edge thereof will cut the degree of the Suns Azimuth, from the North or South part of the Inſtrument, as before. That which is ſaid as to the uſe of the ſaid Azimuth Compaſs, when the Sun is on the Eaſt ſide, the like is to be underſtood with the ſame reaſon, when he is on the Weſt ſide of the Meridian.

And alſo note that the Obſervations of the Azimuth of the Sun, are beſt when the Sun is not very high above the Horizon, not exceeding 15 or 20 degrees; which Obſervations, when they are ſo taken, are the moſt true, becauſe the motion of the Sun, both to his Altitude, as well as to the Azimuth, are more eaſie to be diſcovered.

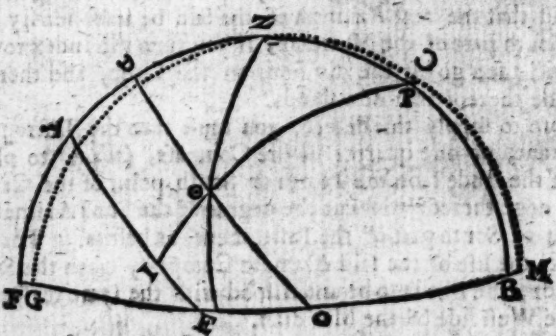
The manner of Working an Obſervation, taken by the Azimuth Compaſs, to find the Variation.

When you have taken the altitude of the Sun by your Almicanter Staff, and alſo the Magnettical Azimuth at the ſame time, by the Compaſs, note them down.

Then conſider the nature of the work that you are to perform, which is to find the difference between the Magnetick Azimuth, and the true, which difference is called the Variation of the Compaſs.

So that the Magnettical Azimuth of the Sun is found by the Compaſs. And the Solar Azimuth is found by Calculation, having three known ſides of an Oblique Spherical Triangle given to find an Angle, *viz.* the Angle of the true Azimuth of the Sun.

And that the enſuing work may be the better conceived, let F Z B (in the Anexed Scheme) repreſent the Meridian of any place, where the obſervation is made; as ſuppoſe it were any part of the City of *London*.



Let Z be the Zenith or Pole of the Horizon, F O B, the Elevation. B P, 51° 32′. Z P, the Complement thereof. A E, the Equator. D ⊙ O, a Northern parrallel of the Suns Declination. Z ⊙ E, a Quadrant of a Verticle Circle, interſecting the Suns parrallel, and paſſing through his Center in the point ⊙. ⊙ E, the Suns Altitude above the Horizon 25° 58′. And Z ⊙, the Complement thereof, or diſtance

diſtance from the Zenith. ⊙I, the Suns Declination from the Equator 23° 22′. ⊙P, the diſtance of the Sun from the Pole of the World or Complement of the Declination 66° 38′, Alſo let the obſcure Perephery M Z G be the Magnettical Meridian, paſſing through the Zenith Z, and deflecting or varying from the true Meridian, by the Arch B M, the meaſure of the Angle M Z B, the variation inquiried, which will be determined by comparing the Magnettical Azimuth, C Z ⊙, with the Solar Azimuth PZ⊙. Therefore in the Oblique Spherical Triangle P Z ⊙, whoſe ſides are already known. The Angle P Z ⊙, may according to theſe enſuing directions be obtained.

The Rule.

Firſt of all, add the three given ſides together, *viz.* The Complement of the Lattitude; the Complement of the Altitude, and the Complement of the Declination into one ſum; and then take the half thereof, from that half ſubſtract the Complement of the Declination, and note the remainder.

And then the proportion will be thus,

1. As the Radius is, to the Co:ſine of the Lattitude,
ſo is the Co:ſine of the Altitude;
to a fourth ſine.

2. As that fourth ſine, is to the ſine of the half ſum,
ſo is the ſine of the Difference,
to a ſeventh ſine.

Unto which if you add Radius, half that ſum will be the ſine of an Ark, whoſe complement being doubled, is the Azimuth from the North part of the Meridian.

Example in the foregoing Scheme.

Add the Comp. of the { Suns dec. / Latt. / Alt. } which is the ſide { P ⊙ 66° 38′ / P Z 38 28 / Z ⊙ 64 02 } into one ſum:

ſum	169	08
½ Sum	84	34
The Suns diſt. from Pole ſubſtract	66	38
The Difference	17	56

Then according to the foregoing Rule			
ſay, as Radius,		10,000000	
to the Coſine of the Lat. 38° 28′		9,793831	
ſo is Coſine Alt. 64 01		9,953783	
to the fourth ſine	fourth ſine	19,747654	
then as this 4th is to the ſine of the ½ ſum		9,998044	
ſo is the ſine Rem.		9,488424	
to the ſeventh ſine		19,486468	
to which add Radius		19,738854	42° 15′
	½ ſum ſine 47° 45′	9,869427	42 15
			84 30

Whoſe Complement being doubled, is 84° 30′, which is the Suns true Azimuth from the North part of the Meridian, *viz.* the Angle B Z E, the Complement of which, to 180°, is 95° 30′, the Azimuth from the South part of the Meridian, which is the Angle E Z F. And at the ſame time obſervation being made by the Azimuth Compaſs, and the Magnettical Azimuth found to be 86° 04′ from the North, from which, the Solar Azimuth (being the leſſer) ſubſtracted the remainer, 01° 34′ is the Variation ſought, which is repreſented by the Angle B Z M or F Z G.

Note, that in Calculation of the Suns Azimuth, it is to be obſerved, that by the Complement of the Declination, is meant, the Suns Meridional diſtance from the elevated Pole, *viz.* If the Latitude of the place of obſervation, and the Suns Declination be Cognominals, (that is, both Northerly and Southerly) then the Suns Declination being ſubſtracted from 90° 00′, leaves a Reſiduum or Remainder, which is the Complement required. But if the Lattitude and Declination be incognominal, (that is, if the one be Northerly, the other Southerly) then the Declination being added to 90° 00′, the aggregat, or ſum, is the Complement of the Suns Declination required.

Another Rule to perform the ſame Work.

When you have added the three ſides together, (as before) and found the ½ ſum, and ſubſtracted the Coſine of the declination therefrom; and ſo found the remainer, you may then proceed according to this following Rule.

Add

Add the fine of the remainer, and the fine of the half ſum, and the Reſiduum or Complement Arithmetical, of the Complement of the Latitude, and the Cotar. of the Cotalt. in one ſum, the half of which ſum ſhall be the fine of an Arch, which being doubled, is the true Azimuth from the South part of the Meridian, the Complement whereof, is the true Azimuth from the North part of the Meridian; as may appear by this following Example, in working the ſame obſervation before going.

Operation.

The Comp. of the	Latt.	38°	28′	into one ſum.
	Alt.	64	02	
	☉ dec.	66	38	
	ſum	169	08	
	½ ſum	84	34	
Suns diſt. from the Pole		66	38	
	Remainer	17	56	

The fine of	Remainer	9,488424	
	½ ſum	9,998044	
Cotar. of Co.	Lat.	0,206168	
	Alt.	0,046216	
	ſum	19,738852	
	½ ſum	9,869426	fine 47° 45′

Which being doubled, is the true Azimuth from the South part of the Meridian, viz. 94° 30′: the Comp. of which is 84° 30′ the Azimuth from the North.

The Reſiduum or Complement Arithmetical of a fine, is onely the Remainer of any fine, being ſubſtracted from Radius:

As for Example. The fine of 38° 28′ is 9,7938317

Which number being ſubſtracted from Radius, the remainer is the Cotar. of that fine, as doth here appear, viz.

10000000	
9,7938317	
0,2061683	

The

The manner of working these Observations by *Gunters Ruler.*

After you have added the three Complements together, and prepared the work for Operation, as before, then you may proceed according to these following directions.

And the Proportion is as before.

1. As Radius
is to the Co:sine of the Lat.
so is the Co:sine of the Alt.
to a fourth sine.

2. As this fourth sine
is to the sine of the half sum,
so is the sine of the remainer
to a fourth sine.

The seventh sine being found, the halfe distance (being taken upon the line of the sines) between that, and the sine of ninty, will be the sine of an Arch, which being doubled, will be the Azimuth required.

The work of the last Example.

Extend the Compass upon the line of sines, from the Radius, or sine of ninty, to the Co:sine of the Lat. 38° 28′, with that distance between the Compass, set one foot in the Co:sine of the Suns Altitude, which is 64° 02′, and the other foot the same way, will fall upon a fourth sine; then let that foot stand at the fourth sine, and extend the other foot to the sine of the half sum, which is 84 degrees 34 minutes: Then with this extent, one foot being set in the remainer 17° 51′, the other foot extended toward ninty, will fall in a seventh sine; then the half distance between this seventh sine, and ninty, being taken with the Compasses, the foot will fall upon the sine of an Arch 47° 45′, which being doubled, will be the Suns true Azimuth from the South, 49° 36′; the Comp. of which is 85° 24′, the Azimuth, from the North part of the Meridian.

But if on the Ruler there be placed a line of versed sines, joynted with

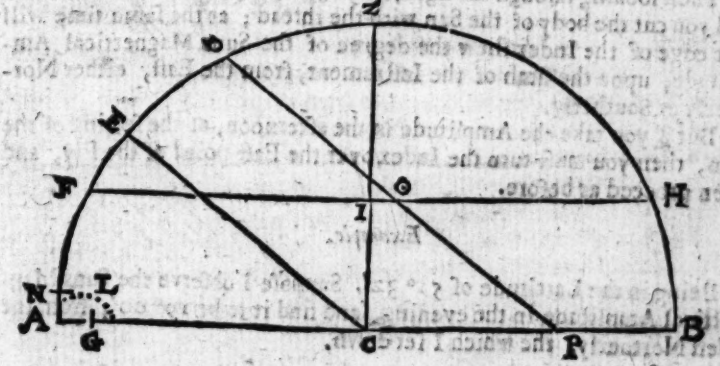
with the right fines, then this laſt Operation of haluein the diſtance, may be altogether omitted, for right againſt the ſeventh ſince, in the right fines, ſtands 84° 30′, in the line of verſed fines, which is the Azimuth from the North part of the Meridian, whoſe Complement, (*viz.* 95° 30′, is the Suns Azimuth from the South part, required.

To find the true Azimuth by the plain Scale.

The Directions in general illuſtrated by the annexed Diagram.

Firſt, Draw the right line A B, which is to repreſent the Horizon of any place; and then opening your Compaſſes to the Radius of the Scale, ſet one foot in the point C as a Center, and deſcribe the Circle A Z B; and from the point C, erect a perpendicular, as the line C Z; ſo having proceeded thus far, I ſhall now proceed to a particular Example of the foregoing Caſe.

Therefore take the Complement of the Lattitude of the place propoſed, which is 38° 28′, out of the line of Chords, and ſet that diſtance from A to B, then draw the line E C, which repreſents the Equator,



Then take the Declination of the Sun out of the line of Chords, which is 23° 22′, and becauſe it is Northerly, ſet it off in the ſame Circle from

from E to D; (but if the Declination had been Southerly, then you ſhould have ſet it from E towards A) draw the line D P parrallel to E C, which repreſents the parrallel of the Suns Declination; then take the Almicanter of the Sun out of the line of Chords, 25° 58′, and ſet it from A to F, and from B to H, and then draw the line F H, which repreſents the parrallel of the Suns Almicanter; then take your Compaſſes, and ſet one foot in the point I, in the croſſing of the lines, and extend the other foot to the point F, that extent ſet off from C to G; then take the diſtance I ☉, (which point ☉, repreſents the place of the Sun) and with that Extant ſet one foot of the Compaſs in the point G, and with the other foot, draw the ſmall occult Arch at L; then a Ruler being laid from the Center C, to the convexity of that ſmall Arch, it will cut the Arch A E Z, in the point N, then take the diſtance upon the ſame Circle from Z to N, which being meaſured upon the line of Cords, it will be 84° 30′, the true Azimuth from the north part of the Meridian.

To take an Amplitude by the Azimuth Compaſs.

If the Amplitude be taken in the morning, at the riſing of the Sun, then you muſt turn the Center of the Index right over the Weſt point of the Fly, and rectifie the Inſtrument by the lines within the Box, to the lines on the Fly.

Then looking through the ſight, turn the Index toward the Sun, untill you cut the body of the Sun with the thread; at the ſame time will the edge of the Index ſhew the degree of the Suns Magnettical Amplitude, upon the limb of the Inſtrument, from the Eaſt, either Northerly or Southerly.

But if you take the Amplitude in the afternoon, at the ſetting of the Sun, then you muſt turn the Index over the Eaſt point of the Fly, and then proceed as before.

Example.

Being in the Lattitude of 51° 32′. Suppoſe I obſerve the Suns Magnettical Amplitude in the evening, and find it to be 19° 00′, from the Weſt Northerly, the which I ſet down.

The manner of working the Amplitude is thus

Firſt, I find the Declination by the Table aforegoing, to be that day 15° 10′ Northerly.

There-

Therefore having the Lattitude of the place, and the Declination of the Sun given, the way of finding the Suns true Amplitude, is thus.

Firſt, by the Artificial Tables the proportion is,

As the Co-ſine of the elevation of the Pole, is to the ſine of the Suns Declination, ſo is Radius to the ſine of the Suns true Amplitude.

Therefore look the Co-ſine of the Lat. which is	38° 28′	9,793831
and the ſine of the Suns Dec. which is	15 10	19,417683
unto which ſine add Radius, and then ſubſtract the upper number therefrom, and the remainder is the ſine of the Suns true Amplitude, which is	24° 52′	9,623852

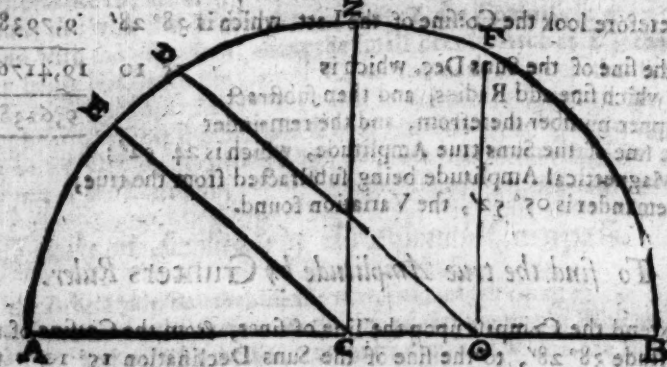
the Magnettical Amplitude being ſubſtracted from the true, the remander is 05° 52′, the Variation found.

To find the true Amplitude by Gunters *Ruler.*

Extend the Compaſs upon the line of ſines, from the Co-ſine of the Lattitude 38° 28′, to the ſine of the Suns Declination 15° 10′, the ſame extent applyed from Radius, or ſine of 90, will reach to the ſine of the Suns true Amplitude, 24° 52′.

To find the true Amplitude by the plain Scale.

First, Draw the line A B then with the Radius of your Scale; and upon C as a Center; draw the Arch A Z B, then take the Complement of the Lattitude out of the line of Chords, which is 38° 28′, and set it off



from A to E; then draw the line E C, which doth represent the Equator; then take the declination of the Sun from the line of Chords, which is 15° 10′; and because it is Northerly, set it from E to D, then draw the line D ⊙ parrallel to E C, which doth represent the parrallel of the declination of the Sun; and from the point ⊙, draw the line ⊙ F parrallel to C Z, and the Ark intercepted between Z and F, being measured in the line of Chords, you will find to be 24° 52′, from which substract the Magnettical Amplitude found by Observation, and the remainer is the Variation.

The Variation of the Compass being thus found several wayes, yet it is of absolute necessity to know which way to cast it; for otherwise there may accrue an intollerable error.

Therefore for the prevention of which, you may observe these following Rules.

I. By the Observation of the Azimuth,

In the Forenoon.

1. If the Angle of the Suns Azimuth (by Calculation) from the North part of the Meridian, be greater then the Magnetical Azimuth, (by observation) then is the Variation Easterly.

2. If the Angle of the Suns Azimuth, from the North part of the Meridian, be less than the Magnettical, then is the Variation Westerly.

In the Afternoon.

3. If the Suns Azimuth, from the North part of the Meridian, be greater then the Magnettical, then is the Variation Westerly.

4. If the Suns Azimuth, from the North of the Meridian, be less then the Magnetical, then is the Variation Easterly.

Example, 1.

Suppose on the fourth of *June* 1669. in the forenoon, (the Suns Declination being 23° 22′ North, in the North Lattitude of 51° 32′) I set the Sun with my Azimuth Compass, and find his Magnettical Azimuth to be 86° 04′ from the North, being 25° 58′ above the Horizon; at the same time the Suns true Azimuth by Calculation, is 84° 30′ from the North part of the Meridian.

The difference of these Azimuths (which is the Variation) is 01° 34′; I demand which way the Compass varies?

Answ. Westerly, because the Observation being made in the forenoon, and I find the Suns true Azimuth (from the North part of the Meridian) to be less then the Magnettical, according to the second Rule aforegoing.

Example, 2.

Admit that in the afternoon, at the same time that I find the Suns true Azimuth to be 102° 00′, I find his Magnettical to be 96° 00′ from the North.

The difference is 09° 00′, I demand which way the Compass varies?

Answ. Westerly, because the Observation being made in the afternoon, I find the Suns Azimuth from the North, to be greater then the Magnettical, according to the third Rule.

Note, Theſe four Rules for caſting the Variation, by Obſervation of the Suns Azimuth, are as well practiſeable in South as in North Latitudes, and are proper, the Suns Declination being either Northerly, or Southerly.

2. By the Obſervation of the Amplitude.

At Sun Riſing.

1. If the Suns true Amplitude be nearer to the North part of the Meridian, then the Magnettical, then is the Variation Weſterly.

2. If the Suns Amplitude be farther from the North part of the Meridian, then the Magnettical, then is the Variation Eaſterly.

At Sun Setting.

3. If the Suns Amplitude be nearer to the North part of the Meridian, then the Magnettical, then is the Variation Eaſterly.

4. If the Suns Amplitude be farther from the North part of the Meridian, then the Magnettical, then is the Variation Weſterly.

Example.

Admit that by the Azimuth Compaſs, at Sun ſetting, I find the Magnettical Amplitude to be 19 deg. 00 min. and the Suns true Amplitude to be 24 deg. 00 min. from the Weſt Northerly, I demand which way the Compaſs varies?

Anſw. Eaſterly, becauſe by an Obſervation at Sun ſetting, the Suns Amplitude is nearer to the North, then the Magnettical, according to the third Rule.

Having, by the former Rules, found the quantity and quality of the Variation, it yet remains, that there be ſome directions for rectifying the Courſe.

The manner that I ſhall here ſet down, is performed by a Compaſs-Chard, having degrees on the limb, and a pair of Compaſſes, which though it be Mechanical, yet it's facile and demonſtrative, and in my Opinion, exact enough for Nautical Uſes.

But before we deliver the Rule for Operation, it will not be amiſs, for plainеſs ſake, to give theſe cautions.

1. That when a man directly aſpects the North part of the Hori-

zon,

zon, the East is on his right hand, and the West on his left: and therefore when the North point of the Compass (and consequently all the other points) vary from the true North or Meridian to the Eastwards then the Variation is reckoned to the right hand; and for the same reason, if the Variation be Westerly, its accounted to the left.

2. That in the use of the Compass-Chard, you must always observe, that you place the Course or Point on which you steere right from you, supposing the eye to be in the Center of the Chard, directly aspecting the course lying evenly before you.

The Rule.

Take the quantity of the Variation in degrees, from the limb of the Chard, between the Compasses, (the Chard lying before you, as is directed) and placing one foot in the Magnettical Rumb or Course; if the Variation be Easterly, turn the other foot towards the right hand, but if it be Westerly, to the left; the number of degrees in which the point of the Compass stayes, shews the true course from the North or South, either Easterly or Westerly, the quantity and quality of the Variation being allowed.

As for Example.

1. Let the Magnettical Rumb, or Point of the Compass, be North-East, and the Variation 10 degrees Easterly, I demand the true Rumb?

The Chard lying, as is directed, take the extent of 10 degrees, between the Compasses, and place it from the North East towards the right hand, because the Variation is Easterly, that shews the true Course to be North East 55 degrees.

2. Let the Course, by the Compass, be West and by South, *(i. e.)* S. W. 78 deg. 45 min. and the Variation 10 degrees Easterly, as before, I demand the true Rumb?

Take the extent of 10 degrees between your Compasses, and place it from W. and by S. towards the right hand, it shows the true Rumb to be S. W. 88 deg. 45 min.

3. Let the Magnettical Rumb be West, and the Variation 10 deg. Easterly, I demand the true Course?

Take the extent of 10 degrees, as before, set it off from the West towards the right hand, it gives the true Rumb North West 80 deg. 00 min.

4. Let

4. Let the Magnettical Rumb be N. N. W. the Variation 10 deg. Westerly, I demand the true Rumb?

Take the extent of 10 deg. place it from the N. N. W. towards the left hand, because the Variation is Westerly, it gives the true Rumb N. W. 32 deg. 30 min.

5. Let the Course, by the Compass, be West, the Variation 10 deg. Westerly, I demand the true Course?

Take the quantity of the Variation 10 degrees, place it from the West towards the left hand, which shews the true Rumb to S. W. 80 degrees.

The Description of the Equinoctial Compass.

This compass is so called, because the Brass Circle, by which most of the following conclusions are performed, representes the Equinoctial.

The Compass is like a Meridian Compass, having the Chard divided into 360 degrees. Also it hath four black lines drawn on the inside of the Box, and two threads or Lute strings stretched from the ends of those lines, close under the Glass, intersecting each other at right Angles: on the outside of the Box are two sights fitted opposite to one another, the one close, the other open; the Close sight is to look through, the open one hath a thread in the middle of it, to cut the Sun in the time of Observation of the Amplitude.

Also the said Sights serve for supporters of the Equinoctial Circle, which Circle hath two Axeltrees diametrically opposite, and a Quadrant fixed thereto, sliding by the side of the Sight, useful to rectifie the Circle in any Latitude.

And lastly, In the Center of this Equinoctial Circle, is placed a long Brass Wyer, passing through the Center, representing the Axis, and the ends thereof the Poles of the World.

This Instrument thus fitted, performes these following conclusions.

The

The Figure of the Equinoctial Compass.

I. To find the Amplitude by the Equinoctial Compass.

For the performance hereof, there needeth no more but the two perpendicular Sights only that are on each side of the Box. Therefore when you have brought the Compass upon the Deck, if it be in the morning or evening; firſt, Let the Card of the Compass ſtand in his due poſition: and then turn the Sight which hath a thread in it, towards the

the Sun; and looking through the close Sight, turn the Box too and again until you cut the body of the Sun with the thread, then at the same time, the line within the Box, under the open Sight, will cut the degrees of the Suns Magnetical Amplitude, either Northerly or Southerly, according to the Declination of the Sun.

The manner of working the Observation to find the Variation, you will find in the use of the Azimuth Compass.

2. To find the Altitude, and Magnettical Azimuth of the Sun.

To perform this conclusion by the Equinoctial Compass, you must put on the Equinoctial Circle between the two perpendicular Sights, together with the brass Pin or Axis, through the Center thereof, which being so fitted, it is thus to be used.

The Card being upon the Pin, and standing in the North position, turn the Compass about, so that the brass Pin in the Center of the Equinoctial plain (called the Axis) may be turned right against the Sun, until it hath no shadow; which being done, at the same time you have cut by the line in the Box (right under the elevated end of the Axis) the Magnetical Azimuth of the Sun, either to the East or West-ward of the Meridian, according as it is morning or evening. And also at the same time, on the Quadrant, is cut the degrees of the Suns Altitude by the edge of the Sight.

3. To find the Variation of the Compass, at one Observation, by the Equinoctial Compass, without any help of Calculation.

This is to be performed when the Sun is just upon the Meridian, which may also be discovered by the Instrument, for if you bring it upon the Deck, before the Sun has its greatest Altitude, turn the Axis right against the Sun until it hath no shadow; and so keeping it still against the Sun, you will perceive it to rise by the Quadrant; and when you see it to be at the greatest Altitude, then at the same time, by the line within the Box, under the Axis, is cut the Variation of the Compass, without any more trouble; and at the same time also is cut the Meridian Altitude of the Sun. And if the Sun happen to be in

in the Zenith, then you muſt turn down the Axis, ſo that it be parallel to the Horizon, and then note when the ſhadow of the Axis falleth upon the line that is in the middle of the Box, or diamiter that paſſeth croſs the Equinoctial Circle, and at the ſame time will be cut the Variation (by the North or South point of the Compaſs) by the line within the Box.

4. To find the hour of the day in all places of the World by the Equinoctial Compaſs.

For the performance of this concluſion, you muſt rectifie the Equinoctial Circle, by putting the degree of Latitude on the Quadrant, to the edge of the ſight. The Circle being thus rectified, turn the Axis right over the North and South points of the Card, with the higheſt end of it toward the elevated Pole; if it be in North Latitude, the Sun having North declination, then the hour of the day will be ſhadowed by the Axis, upon the upper ſide of the Equinoctial Circle: But if the Sun hath South Declination, (that is on the other ſide of the Equinoctial) then you muſt look on the under ſide of the Equinoctial Circle, for the hour of the day. The ſame alſo is to be underſtood in South Latitude, if the Sun have South Declination, look on the upper ſide; if North Declination, on the under ſide of the Equinoctial Circle for the hour of the day.

5. To know if the Sun be in the Zenith (or not) by the Equinoctial Compaſs.

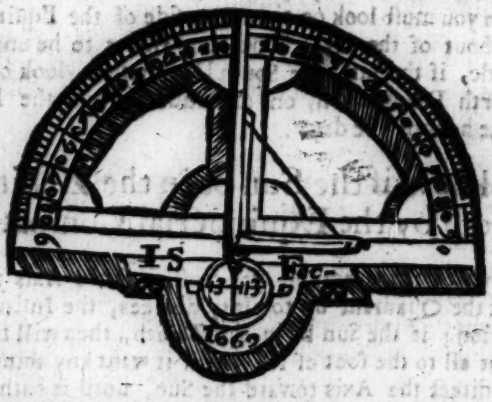
For the performance hereof, you muſt erect the Axis perpendicular, and put the Quadrant up to ninty degrees, the Inſtrument being in this Poſition; if the Sun be in the Zenith, then will the Axis caſt no ſhadow at all to the foot of it; but if it want any thing of the *Zenith*, then direct the Axis toward the Sun, until it hath no ſhadow, and then you may perceive by the degrees on the Quadrant, how much it wants thereof.

The Description of the Semi-circle.

This Instrument is made in Wood, and intended principally for Sea Observations. It derives its name from his form, being an half Circle, containing 180 degrees upon the Limb, which are numbred from the middle, both wayes, with 10, 20, 30, to 90. and subdivided into minutes by Diagonal Lines and Concentrick Circles.

On the Diameter of this Instrument, is made a Compass Box, containing a Needle with a Fly, crossed with two Diamiters at right Angles, representing the four Cardinal Points. Likewise on the inside of the Box, are drawn four black lines, and from the ends of them are two Threads, or Lute-strings stretched close under the glass. Furthermore, in the Center of the Semi-circle, is placed an Index, with an Erect Sight, and an Hypothenusal Thread, as it is represented in the following Figure.

The Figure of the Semi-circle.



This Instrument is more antient then the Azimuth Compass, although it be not so commodious for use; for in the time of Observation, it alwayes ought to be in an Horizontal Position, from which (as commonly used) it is altered by reason of the Ships unsteady motion; and for that reason, renders the Observation not altogether so true as the Azimuth Compass.

The

The Use of the Semi-circle.

The use of this Instrument, is chiefly to observe the Magnettical Amplitude and Azimuth of the Sun.

1. For Observation of the Amplitude.

When there is a seasonable opportunity of Weather, place the Instrument to lie (as near as possible) parrallel to the Horizon, keeping it in that position, turn the Arch towards the Sun, (and if it be in the forenoon) place the Center of the Semi-circle to the East point of the Fly, rectifying it by the lines and strings within the Box; then turn the Index towards the Sun, till looking through the perpendicular Sight, you see the Hypothenusal thread cut the Center of the Sun; at the same time the Index shews the degrees and minutes of the Magnettical Amplitude upon the Limb, from the East point of the Compass, towards the North or South, according to the nature of the Observation; if the Observation be taken in the afternoon, do the contrary.

2. For the Observation of the Azimuth.

The Instrument lying parrallel to the Horizon, turn the Arch towards the Sun, setting the Center to the North or South points of the Fly, (according to the Suns Coast) and rectifie it by the lines in the Box, then turn the Index towards the Sun, until the shadow of the Hypothenusal thread falls upon the fiducial line drawn thereon; at the same time is shown upon the Limb, the degrees and minutes of the Suns Magnettical Azimuth from the North or South, either Easterly or Westerly, according to the time of the Observation, before or after noon.

If at any time happen, that the Suns Magnettical Azimuth be more then 90 degrees from the North or South, then turn the Instrument about just one Quadrant, or 90 degrees, and rectifie the Center of the Instrument to the East or West points of the Fly, (according to the season of the Observation before or after noon) the degrees and minutes intersected by the Index, is the Suns distance from the East or

Weſt points of the Compaſs, which added or ſubſtracted, to or from 90 degrees, will give the Magnetical Azimuth from the North or South, according to the Suns Coaſt.

If any thing, through brevity, ſeem obſcure in the uſe of this Inſtrument, I refer you, for further ſatisfaction, to the precedent Diſcourſe of the Azimuth Compaſs, and likewiſe for the working of your Obſervations, where this matter is handled more at large.

And ſometimes there is uſe made of an ordinary Meridian Compaſs, with two ſights on each ſide of the Box, and is commonly called an *Amplitude Compaſs*; it being capable of taking the Magnetical Amplitude of the Sun, which is thus to be performed.

If the Obſervation is to be taken in the morning, at the riſing of the Sun, then muſt you turn the Sights toward the Sun, with the cloſe Sight next your eye, until you juſt cut the body of the Sun with the thread in the open ſight; then at that very time look within the Box, and the black line that is under the open ſight, will ſhew the degree of the Suns Magnettical Amplitude, either to the Northward or Southward of the Eaſt or Weſt point of the Compaſs, according to the ſeaſon of the Obſervation, whether in the morning or evening, and alſo the time of the year.

The Deſcription of the Univerſal Ring-Dial.

This Inſtrument conſiſts chiefly of two Rings, cloſely fitting within each other, and a Bridge, and is made either of Braſs or Silver,

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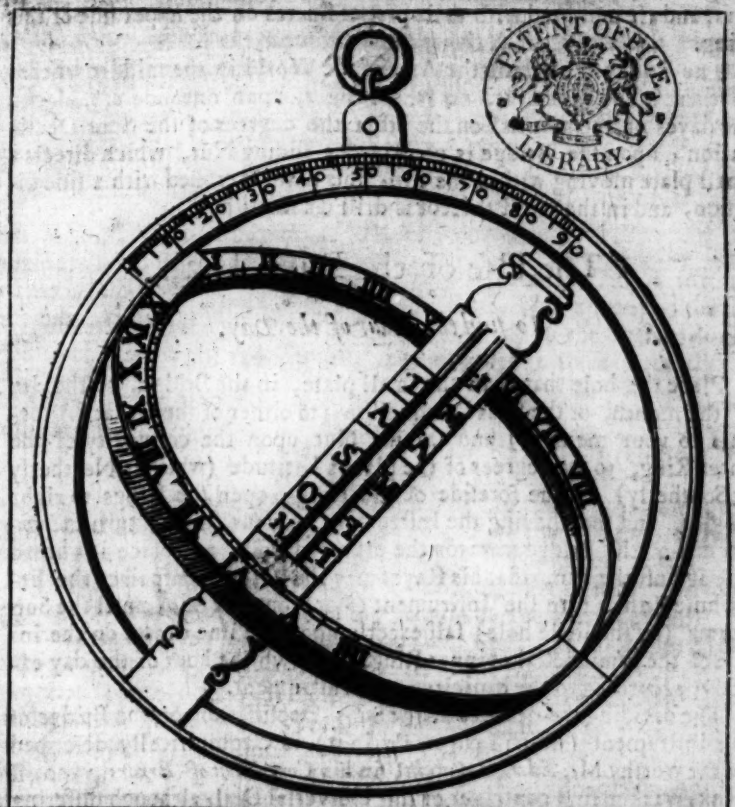
The

The Figure of the Ring-Dial.



The outtermoſt Ring, repreſents the Soltitial Colure, and on the foreſide, has one of its upper Quadrants divided into 90 degrees; likewiſe on the back ſide a Semi-circle is divided into the like number of degrees from the Hole or Center in the circumference; on the Convexity of this Ring is fitted a Nut (with a Wyer Ring to it) having a ſmall line drawn in the middle of it, to remove to any of the degrees on the foreſide.

The

The inner Ring (when they are open at right angles) repreſents the Equinoctial Circle, on the inſide of which is drawn a line in the very midſt, and thereon are divided the hours into halves and quarters, and are numbred with their proper figures on the upper ſide of this Ring.

The Bridge repreſents the Axis of the World, in the middle whereof there is cut a long ſlit, on whoſe edges, upon one ſide are placed the dayes of the month, on the other the degrees of the Suns Declination; upon the Bridge is contrived a ſliding Nut, which directs a ſmall plate moving within the ſlit; this plate is croſſed with a fine diviſion, and in the midſt thereof is drill'd a ſmall hole.

The Uſe of the Ring-Dial.

To find the Hour of the Day.

Place the hole that is in the ſmall plate, in the Bridge, to the day of the month, or the Suns Declination (to either of them that firſt occurs to your memory) and ſet the Nut upon the convexity of the outer Ring, to the degrees of the places Latitude (whither Northerly or Southerly) on the foreſide of the Ring; open the Rings to right Angles, and then having the Inſtrument on your finger, turn the upper end of the Bridge towards the elevated Pole, and place it a broad ſide againſt the Sun, that his Rayes may the better tranſpeirce the little hole; then turn the Inſtrument to or from the Sun, until the Sun beams (by the little hole) fall exactly upon the line drawn on the inſide of the Equinoctial or inner Ring, is ſhown the hour of the day exactly, according to the capacity of the Inſtrument.

The dividing the degrees of the Suns Declination on the Bridge of this Inſtrument (which I purpoſely in it) is Geometrically deſcribed by the worthy Mr. *Edward Wright*, in his *Correction of Errors*, who, I think, was the firſt contriver of this Univerſal Dial, although differing from this here diſcourſed of.

To find the Suns Altitude.

To perform this, you muſt firſt ſet the line in the midſt of the Nut, upon the outer Ring, to the beginning of the degrees on the foreſide of the ſame, then put a pin into the Center hole, and hanging the Dial upon your finger, turn the edge of the outer Ring towards the Sun,

ſo

ſo as the ſhadow of the Pin may fall upon the diviſions on the backſide, the number of degrees interſected by the ſhadow, gives the Suns Altitude.

To find the Variation by the Ring-Dial, being fitted on a Meridian Compaſs.

This Inſtrument may be ſo fitted to a Meridian Compaſs, as to ſhew both the quantity and quality of the Variation, with much facility, by inſpection only, at any hour of the day.

To perform this, the limb of the Chard ought to be divided into 360 degrees, and the inſide of the Compaſs Box into four equal parts, having four perpendicular lines drawn thereon, upon the Box over the Glaſs, is a ſtrong plate of Braſs to be fitted, reſpecting the lines drawn within the Box; in the midſt of this plate the Dial is to ſtand perpendicularly, upon a moveable foot, with a Nut contrived for the rectification of the Rings, which is to be placed to the degrees divided on the foreſide of the outward Ring, oppoſite to thoſe formerly deſcribed.

The manner of finding the Variation by this Inſtrument.

It being thus fitted, ſet the hole in the Bridg to the day of the month, open the Rings to the right Angles, and rectifie them to the Latitude of the place, by the Nut and Tooth, from the foot laſt deſcribed, and find the hour of the day, as is already ſhown, and then keeping the ſpot of the Sun Beams exactly upon the middle of the Equinoctial Ring, at the ſame time the black lines in the Box, under the braſs Plate, do repreſent the true North and South parts of the Meridian of the place, therfore ſuddenly caſt your eyes upon the North point of the Compaſs, and obſerve how it ſwerves from the black line (and note the quantity of degrees, cut by the limb of the Chard) for the ſame is the Variation, which is naturally and lively demonſtrated by this Inſtrument, both in the quantity and quality, either to the Eaſtward or Weſtward of the true Meridian.

Example.

Suppoſe that at any time, having found the hour of the day by this Inſtrument, you diſcover the North point of the Compaſs, to ſwerve to the Weſtward of the black line, and two degrees to be intercepted on the Limb of the Chard, this ſhews the Variation to be two degrees Weſterly: and on the contrary, if the North point had ſwerved the ſame number of degrees to the Eaſtward of the Line, then had the Variation been two degrees Eaſterly.

The

The Figure of the Croſs-Staff.

The Deſcription of the Croſs-Staff.

This Inſtrument is of ſome antiquity in Navigation, and is commonly uſed at Sea, to take the Altitude of the Sun or Stars, which it performs with ſufficient exactneſs, eſpecially if it be leſs then 60 degrees, but if it exceed 60, it is not ſo certain, by reaſon of the length of the Croſs, and the ſmallneſs of the graduations on the Staff.

The

The Staff is made ſtreight, four ſquare, and commonly of Box or Pear Tree, and graduated on the ſeveral ſides with degrees and minutes.

The Croſſes, uſually four, are commonly made of the ſame Wood with the Staff, of a convenient breadth, and of length proportional to the Graduations, fitted to ſlide evenly upon the Staff, with any jogging, or ſecond motion.

On one ſide of the Staff, the Graduations begin about three degrees, and proceeding towards the Center, or the end, increaſe by every ten minutes, to ten degrees, and this ſide is called the ten ſide, and the Croſs thereto belonging (the ſhorteſt of the four) the ten Croſs, whoſe whole length (if rightly made, and the Staff truly divided) ſhall reach on this ſide from 10°, unto 8° 31′, and his half length from 10° to 9° 11′.

On another ſide of the Staff, the diviſions begin at about 10 degrees, and increaſe upwards to 30 degrees, this is call'd the thirty ſide, and its Croſs the thirty Croſs, whoſe whole length ſhould reach on this ſide from 30 deg. to 19 deg. 47 min. and the half length from 30 deg. to 23 deg. 52 min.

On another ſide the graduations begin about 20 deg. and increaſe toward the eye end of the Staff to 60 deg. this is named the ſixty ſide, and the Croſs peculiar to this ſide, is called the ſixty Croſs, whoſe whole length ought to reach on this ſide from 60 deg. to 30 deg. and the half length from 60 deg. to 40 deg. 13 min.

The remaining, and fourth ſide, hath the diviſions beginning at 30 deg. and increaſing upwards to 90 deg. from thence it is named the ninty ſide, and his Croſs (the longeſt) the ninty Croſs, whoſe whole length muſt reach from 90° to 36° 52′, and the half length from 90° to 53° 07′, or from the Center of the Staff, to the beginning of the diviſions, *viz.* to 90°.

Sometimes the ſeveral ſides of the Staff are numbred likewiſe with their Complements to 90°, in ſmall figures, *viz.* at 90° ſtand 00° againſt 80° 10°, at 70° ſtands 20°, and ſo of the reſt.

The uſe of this reverſion, is to take the Complement of the Altitude or Zenith diſtance from the Staff, readily without ſubſtraction.

There are two wayes principally for the graduating a Croſs Staff, one by Geometrical Projection, the other by Arithmetical Calculation; I will give you an Example of the latter, by which you may divide any Staff, or at leaſt be able to examine one that is already graduated.

Example of the ſixty Croſs.

Suppoſe the length of the ſixty Croſs to be 10 $\frac{2}{10}$ inches, and the half length 5 $\frac{1}{10}$ inches, I deſire to know the diſtance of 45° 30′ from the Center of the Staff proportional to this length of the Croſs. Take $\frac{1}{2}$ of 45° 30′, that is 22° 45′.

The Anology is,

As the Tangent of 22° 45′	Cotar.	10.37742
is the $\frac{1}{2}$ length of the Croſs 5 $\frac{1}{10}$ inches	Log.	0.70757
ſo is Radius		
to the diſtance required 12.16 inches		1.08499

This gives the diſtance from the Center of the Staff to the diviſion, repreſenting 45° 30′, to be 12.16 (or $\frac{12}{100}$) inches.

But if you do purpoſe to graduate a Staff, the more ready and expedite way, is to divide the half length of the Croſs into 100 or 1000 equal parts, and taking onely the Tangent Complement of half the Angle required out of a Canon of natural Sines and Tangents.

Example.

Suppoſe, as before, the $\frac{1}{2}$ length of the 60 Croſs, to 5,1 inches, and its required to know the diſtance from the Center to 45° 30′.

The half length of the Croſs being divided into 1000 equal parts, (or into as many as conveniency admits of, the reſt ſupputated by judgment) look into the Tables of natural Tangents, for the Tangent Complement of 22° 45′ (the $\frac{1}{2}$ of 45° 30′) and you will find 238472, then cutting off two figures towards the right hand, the remainder 2384, ſhews the number of equal parts (whereof the half Croſs contains 1000) which muſt be taken, to ſet off the diſtance from the Center to 45° 30′, that is twice the half length of the Croſs, and 384 parts over.

The like you may perform for any other degree, to every tenth or fifth minute, or leſs, according as the Staff will admit of the diviſions; and as you ſee in the example of this Croſs, ſo the like may be performed for any Croſs of what length ſoever.

The

The Uſe of the Croſs-Staff.

To take a forward Obſervation of the Suns Meridian Altitude at Sea.

When you do intend to take the Meridian Altitude at Sea, in reference to the obtaining of the places Latitude, it is convenient that you be preparing your ſelf for your Obſervation, ſome competent time before noon, and conſider what the Suns greateſt Altitude may be eſtimated to be that day; accordingly to uſe thoſe Croſſes that may be moſt pertinent to your purpoſe.

As ſuppoſe the Meridian Altitude for that day be judged to be 20 degrees, then uſe the thirty ſide of the Staff, and the thirty Croſs; if it is thought 'twill be 30 degrees, then take the ſixty Croſs; but if it be eſtimated to exceed both, then the ninty Croſs is moſt proper for your uſe.

There is another requiſite fit to be underſtood before you proceed to Obſervation, and that is, how to place your fore-ſtaff to your eye, to prevent an error mentioned by Mr. *Wright*, in his *Correction of Errors*, to avoid which, take theſe few hints.

Firſt, Place the Center of the Staff at A, to the outſide of the Corner of your eye, as near your eye as conveniently you can, without hindering your ſight, letting the end reſt upon your eye bone, reſpecting, as it were, the eyes Center, and cauſe the viſual Rayes to concur with the middle parrallels drawn on each ſide of the Croſs-Staff, and then is your Staff rightly placed for Obſervation; but becauſe this place is ſomewhat difficult plainly to be deſcribed, and perhaps that which is already ſaid, may not be ſo obvious to the Reader as I could wiſh it; I will therefore give an eaſie demonſtration which may be verified by experience.

Having firſt of all ſatisfied your ſelf in the truth of the diviſions on the Staff, and likewiſe of the exact length, and half length of your Croſſes, then put on the ſixty Croſs, and place it to 30° on his proper ſide, and alſo ſlip on the ninty Croſs parallel with the former, and put that to 30° likewiſe on his peculiar graduations, then bring the end of the Staff to the corner of your eye (as is directed) and remove it ſomewhat higher or lower until you ſee each end of the two Croſſes at once exactly to concur and agree with the viſual lines proceeding from your

eye; that is the place for your Staff in time of Obſervation, and may eaſily be found by frequent trial.

Having thus prepared for your Obſervation, and acquainted your ſelf with the poſiture of your Inſtrument, being upon the Deck, turn your face towards the Sun, and place your Staff to your eye, holding the Vane as upright as you can, look at the upper end of your Croſs, as at C for the Sun, and at the lower at B, for the Horizon; but if the Sea obſcure the Horizon from the Sight, then remove the Croſs a little farther from your eye; but if on the contrary your ſight do not extend ſo low as the Horizon, but the Skie only appears inſtead thereof, then move the Croſs a little nearer your eye, until by the upper part thereof you ſee the Center of the Sun, and by the lower the Horizon exactly at the ſame time, then have your eye upon the proper ſide of the Staff (for the Croſs you uſe) the Suns preſent Altitude will be cut by the ſame; and this, if it were for one ſingle Obſervation either of the Sun, or any Celeſtial body were ſufficient.

But the Suns greateſt Altitude being that you are about to procure, you muſt therefore wait, making Obſervation as your judgment ſhall direct you, until the Sun be upon the Meridian, ſtill ſliding the Croſs nearer your eye as the Sun riſes, until you perceive him to be at the higheſt; for ſo ſoon as the Sun is to the Weſtward of the Meridian, and falling, if you make Obſervation again, you will find the Sea to obſcure the Horizon from your ſight, and then in no caſe remove your Croſs, but let it remain fix'd, and finiſh your Obſervation for that ſeaſon.

Then caſt your eye upon that ſide of the Staff belonging to the Croſs you uſe, the degrees and minutes cut thereby, and numbred with larger figures (decreaſing alwayes from the Center of the Staff) gives the Suns Meridional Altitude, and the ſmall figures underneath the Complement of the Altitude, or the Zenith diſtance.

In obſerving forward by the Croſs-ſtaff, 'tis uſual to have a piece of red Glaſs to defend the ſight from the luſtre of the Sun in time of Obſervation.

['Twould, in my opinion, be better to have the Glaſs fitted in a piece of Braſs, and ſo to put upon the end of any the Croſſes as occaſion requires; thus much for a forward Obſervation.]

After the ſame manner you muſt obſerve the Altitude of the Stars.

To

To make a backward Observation of the Suns Altitude by the Cross-Staff.

These Observations are frequent at Sea, especially with the *Hollander*; And to perform this, you must have a Horizon Vane to fix upon the Center of your Staff, or else a sliding one, according to the *Dutch* fashion.

Likewise there is a Shooe of Brass to fit on to the end of the Crosses, whose use is the same with the Horizon Vane in the Quadrant, and other Instruments; I will briefly shew the use of these Contrivances.

Having a Staff thus fitted, place the Horizon Vane upon the Center or eye end of the Staff, and put on a Cross fittest for your purpose, fix the Brass shooe at the lower end thereof, then turn your back to the Sun, and looking through the sight (made by the Brass Shooe) on the end of your Vane; elevate or depress the end of your Staff, until the shadow made by the upper end of the Cross, fall upon the upper part of the sight in the Horizon Vane, then look through that sight for the Horizon; But if the Sea obscure the Horizon from your sight, then remove your Cross a little farther from the Horizon Vane; but if on the contrary, your sight doth not extend so low as the Horizon, but the Skie only appears instead thereof, then remove the Cross nearer to the Horizon Vane, till you see the shadow fall upon his due place, and perceive the Horizon exactly at the same time, then have you the Suns present Altitude.

If you observe for the Latitude, you must reiterate your Observations as before, and when you perceive the Sun to be past the Meridian, desist; and concluding your Observation, accoune your degrees and minutes either of the Altitude, or its Complement, as is before shown.

If any desire to use the Staff in a backward Observation, after the *Dutch* fashion, the best way is to have a Horizon Vane to slide evenly upon the Staff, and then all the variety from the former manner of Observation will be this, *viz.*

Place any of your Crosses, that you intend to use, upon the Center of the Staff, turning the Nut inwards, then slide on your Horizon Vane with the Nut outwards, and fix on the Brass shooe to the lower end of your Cross; then proceed with your Observation in all respects as before, and the degrees and minutes cut by the inner edge of the Horizon

Horizon Vane, upon the side peculiar to the Cross you use, is the Suns Altitude or Complement thereof, as you reckon it in the greater or lesser Figures.

There is a second contrivance of the Cross-Staff, which in some respects is more convenient then the former, and is commonly used by our Countreymen, by some called the Jacob Staff.

This second contrivance differs little from the former, the Staff being divided and figured after the same order, only instead of the several Crosses in that already described, here is use made onely of one Cross or Transum, and two Vanes sliding thereon.

This Transum is made four square, and fitted to slide upon the Staff after the usual manner; the one side of this Transum is crossed with six short lines, the two neareſt to each other are distinguished with the figures 30, the next two with 60, the remoteſt with 90; There is a Horizon fitted to this much like that of the Quadrant.

The Use of this Instrument is briefly thus.

The long Transum supplies the place of the 30. 60, and 90 Crosses, by the help of the two Vanes sliding thereon. As suppose you had occasion to make use of the thirty Cross, then place the Vanes on the Transum to the divisions under 30, and 30 on each side of the Staff; and then by removing your Transum to and fro, you may observe your Altitude by the edges of the two Vanes, after the same manner as you do with the thirty Cross, on the ordinary Cross-Staff. And the same is to be understood of the rest of the Crosses, so that with this distinction last noted, this contrivance of the Cross-Staff is as useful as any other in all respects and varieties whatsoever: Besides you are not here troubled to shift your Crosses, in case your Altitude should deceive you; (which sometimes happens) and may chance to be the occasion of loosing an Observation; but in this Instrument the Crosses are suddenly altered, only by removing the Vanes to your respective divisions.

Note, That you may place either the upper or lower edge of the Vanes,

Vanes, to the lines on the Transum, as you find most convenient, provided only that you observe by the same edges.

The Description of the Quadrant.

This Quadrant is of a very commodious form and contrivance, being at present the best approved, and most general Instrument that is in use for Observing the Suns Meridian Altitude at Sea.

The parts of this Instrument are principally three Vanes and two Arches, which Arches together contains 90 degrees, and gives it therefore the denomination of a Quadrant.

The

The Figure of the Quadrant.

Of the three Vanes, That which in time of Observation respects the Horizon, in this annexed Figure, represented by A, is called the Horizon Vane; that which gives the shadow, noted by B, is named

med the ſhadow Vane, and that through which you are to look for both Shadow and Horizon, diſtinguiſhed with C, is called the Sight Vane.

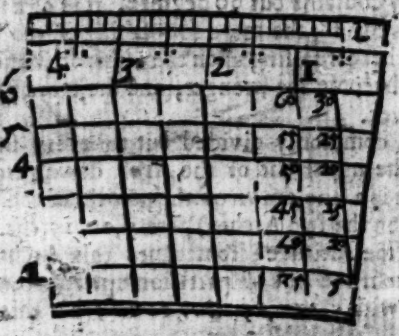
Of the Arches, the leſſer, noted with *d e*, is named the ſixty Arch, becauſe it uſually contains but 60 degrees, it is of a ſmall Radius adviſedly ſo contrived, for the more apt placing of the Vane B thereon, that the ſhadow thereof falling upon the Horizon Vane A, at this ſhort diſtance, might become the ſtronger, and the more perſpicuous to the eye of the Obſerver.

This Arch is commonly divided but to every fifth degree, and numbred from the upper end of the Arch downwards to the line of partition (which is a line drawn on the middle of the upper leg of the *Quadrant* between the two Arches) with 5, 10, 15, *&c.* And this is the Complement of the Altitude; ſometimes this Arch is figured with the Altitude, from the line of partition upwards towards the higher end of the Arch with 5, 10, 15, *&c.* to 60; but this is not frequently uſed.

The greater Arch here denominated by the letters *f*, *g*, is nominated the thirty Arch; this Arch is of a large Radius, the better to be divided and ſubdivided into degrees and minutes, the limb whereof is of a competent breadth, and thereon are uſually deſcribed ſeveral Concentrick Circles, interſected with Diagonal lines, for the more facile and exact dividing the degrees into every tenth, fifth (and ſometimes every ſecond) minute; and hereby the ſubdiviſions are conſpicuous, and may readily be computed by the Obſerver.

But becauſe poſſibly this manner of diviſion may not be underſtood by every one that has occaſion for this Inſtrument, for their ſakes therefore I have annexed this following Figure,

The Figure of the Arch.



Being part of the limb of this Arch, as 'tis usually drawn upon the Quadrant, each degree being subdivided into minutes: upon the plain of this Arch are described six Concentrick Circles, and are noted with the figures 1, 2, 3, 4, 5, 6. And in the limits of each degree are drawn two Diagonals intersecting these Circles; and those two Diagonals divide each degree into two parts, *viz.* into 30 minutes, and the Concentrick Circles subdivide each of these Diagonals representing 30 minutes into six other parts, being five minutes a piece; therefore the first intersection at 5, is 5 minutes; the second at 10, is 10 minutes; the third at 15, is 15 minutes; the fourth at 20, is 20 minutes; at 25, 25 minutes; at 30, is 30 minutes. The first again at 35, is 35 minutes; the second at 45, is 45 minutes; at 50, is 50 minutes; and at 60, 60 minutes or 1 degree in the Margent; and the like is to be understood of the rest; alwayes as they ascend, increasing 5 minutes.

And take this for a general Rule, first count how many Concentrick there are, which are usually six, and are to be computed as is here shown and noted by the figures at the end of this Scheme, then see how many Diagonal lines are drawn within the extent of each degree, which are commonly two, as in this representation, (sometimes for the more curious, there are five drawn within this limit) then multiply the number of Concentrick Circles, by the number of Diagonals in

one

one degree, and by the product, divide 60, the minutes in a degree) the Quotient ſhall give you the number of minutes, that each interſection increaſes by, and is more then the precedent. As ſuppoſe the Concentrick Circles to be (as uſually) ſix, the Diagonals in each degree (which is rare) five, then multiply ſix by five, the product is 30, by which if you divide 60, the quotient is 2; which ſhews that the interſections increaſe by 2 minutes, the firſt repreſenting 2 minutes, and ſo 4, 6, 8, minutes, *&c.* to 58 and 60 minutes, or 1 degree; and then 1 deg. 2 min. 1 deg. 4 min. 1 deg. 6 min, *&c.* and the like is to be underſtood of the reſt.

The Uſe of the Quadrant.

This Inſtrument is ſeldom uſed upon any other occaſion, then to obſerve the Suns Meridian Altitude, which to perform, we will briefly deſcribe.

Firſt, Put on the Horizon Vane on the end of the Quadrant at A, and then the Sight Vane upon the 30*th* A, in the precedent Figure. And laſtly, The upper edge of the Shadow Vane to a certain number of degrees moſt proper for your preſent Obſervation; which readily to perform, take theſe cautions.

Firſt, That you place the Shadow Vane ſo, that the degrees intercepted from the upper edge of the Vane, to the lower end of the 60 Arch be alwayes leſs then you judge the Suns Meridian Altitude will be that day in the place of Obſervation.

But ſecondly, That the degrees intercepted, be not ſo much leſs then the Meridian Altitude; that the difference therefrom exceed not 30 degrees; for in both theſe caſes, the 30 Arch, and ſo conſequently the Quadrant it ſelf is become uſeleſs.

For inſtance, Suppoſe that the greateſt Altitude of the Sun, for the time, and in the place of obſervation, be eſtimated to be 45 deg. then to place the Shadow Vane at 5 or 10 degrees at the upper part of the Arch, would be abſurd, becauſe the Remainders to the lower end of that Arch, being 55 and 50, are more then the Meridian Altitude; and likewiſe to place the Vane at 50 or 55 at the lower end of the Arch, would be as prepoſterous, becauſe the Remainder of degrees, *viz.* 10 and 5, are ſo much leſs then 45, that the difference therefrom exceeds 30 degrees: likewiſe if you place the Vane at 15 degrees at the upper end of the Arch, or at 45 degrees at the lower end thereof, then you muſt uſe the very extremities of the 30 Arch, and there-

fore the middle divisions between 15 and 45, viz. 25, 30, or 35, are most proper for your present Observation.

Having thus prepared your Instrument for observation, and being ready upon the deck, turn your back towards the Sun, and holding the Quadrant as upright as you can, place the Sight Vane to your eye, and looking through the Sight, bring the shadow of the upper edge of the Shade Vane, to fall upon the upper part of the slit or open sight in the Horizon-Vane, and at the same time look through the said slit for the Horizon; and if the Sea obscure the Horizon from your sight, then slide your Sight Vane a little farther up towards *e*; but if on the contrary your sight does not extend so low as the Horizon, but the Skie only presents it self to your eye, then remove your Sight Vane a little lower towards *f*, then make observation again, continuing to move your Sight Vain higher or lower, according to these directions, until looking through the Sight Vane, the shadow fall upon his due place, and that at the same time you exactly see the Horizon through the Sight in the Horizon Vane, then have you the Suns present Altitude; but it being the Meridian or greatest Altitude that you are to observe for, you must therefore continue to make observations as often as you shall think fit, (but especially you are to tend your Observation when you perceive the Sun even almost upon the Meridian) until you perceive it to be to the Westward of the Meridian, and to be lessening his Altitude; for then if you make Observation, the Sea will hide the Horizon; and in this case you must not alter your Vanes, but letting them stand, conclude your Observation for that season: then cast your eye upon the thirty Arch, and see how many degrees and minutes are cut by the inside of the Sight Vane, and thereto add the degrees at the upper edge of your Shadow Vane, the sum is the Complement of the Altitude, or the Suns distance from the Zenith.

Note, The small Arch in some Quadrants contains 70 degrees, and the greater 20 degrees, whose sum is 90. These Arches are numbred and divided like the former; and if that be well understood, this will not seem obscure, and therefore it is needless to say any more of this Alteration.

The manner of working your Observations of the Meridian Altitude of the Sun, taken by this Instrument, shall be largly shown in the general Rules for that purpose.

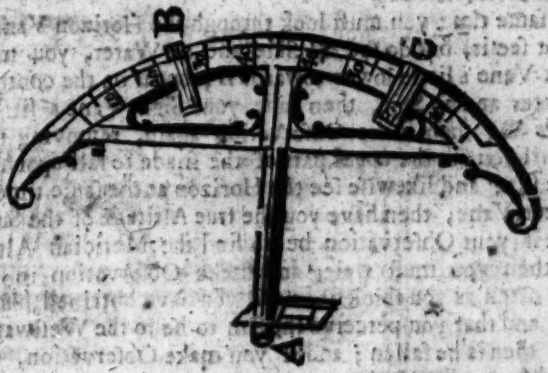
The

The Description and Use of the Cross-Bow Quadrant.

This Instrument is of good use in Navigation, not onely for Observation, but in regard of the portability of it, lying in a little room, which is oftentimes a great conveniency in some Ships; especially, it bears the name of a Cross-Bow Quadrant, because of its resemblance to a Cross-Bow.

This Instrument contains a graduated Arch, a Staff, and three Vanes.

The Figure of the Cross-Bow Quadrant.



The Graduated Arch, is a Quadrant containing 90 degrees, and is numbred from the ends both wayes with 10, 20, &c. to 45 degrees in the middle of the Arch.

In the middle of this Arch is made a shaft and socket, to contain a Staff fitted thereto, to put in for Observation, and remove at pleasure; this shafe, when placed in the socket, is the Radius of the Arch or Quadrant.

The Vanes are, the *Horizon Vane*, the *Shadow Vane*, and the *Sight Vane*, as in the Quadrant.

The

The Use of the Cross-Bow Quadrant.

This Instrument is chiefly to observe the Suns Altitude, which you must thus perform.

First, Put on the Horizon Vane on the end of the Staff, then place the Shadow Vane upon the upper part of the Arch, to some certain degree; and lastly, fit on the Sight Vane on the lower part of the Arch; thus your Bow is fitted for Observation.

Then standing with your back toward the Sun, take the handle of the Bow in your hand, holding the Instrument as upright as you can, then bring your Sight Vane to your eye, and look through your Sight to your Horizon Vane, holding your Bow so as that the upper part of the shade (of your Shadow Vane) may lie upon the upper edge of the slit of your Horizon Vane.

At the same time you must look through the Horizon Vane; and if you cannot see it, but do see all Skie and no Water, you must draw your Sight Vane a little lower towards B; but if on the contrary, you see all Water and no Skie, then slide your Sight Vane a little higher up towards C; then make Observation again, removing the Sight Vane, until you see the upper part of the shade to fall upon the upper part of the slit; and likewise see the Horizon at the same time through the Horizon Vane, then have you the true Altitude of the Sun at that time; but if your Observation be to find the Meridian Altitude of the Sun, then you must wait, and make Observation in the same manner as often as you think fit, until you have obtained his greatest Altitude, and that you perceive the Sun to be to the Westward of the Meridian, then is he fallen; and if you make Observation, the Water will obscure the Horizon, therefore let your Vanes stand upon the Arch, and finish your Observation for that time.

Then look upon the lower part of the Arch, and see what degrees and minutes stand against your Sight Vane, and likewise what degrees do stand against the upper edge of your Shadow Vane, add them together, and the sum is the Complement of the Altitude, or the distance from the Zenith.

This Instrument may also conveniently be used to make a forward Observation of the Altitude of the Sun or Stars, by removing the Horizon Vane, and placing the Center of the Staff to your eye, after the manner of the Cross-Staff, the Vanes supplying the want of Crosses, by fixing one Vane to a certain number of degrees, and removing the

the other upwards or downwards to the degrees and minutes of the Altitude to be observed.

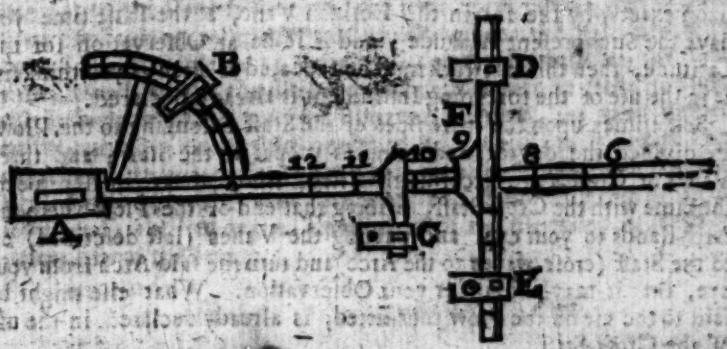
The manner of working the Observations by this Instrument, is hereafter inserted in the general Rules for that purpose.

The Description and Use of the Plow.

The Description of the Plow.

This Instrument was antiently in use amongst Mariners, although at this day it is not so commonly used as formerly; it consists of a Staff having a small Arch, and three Vanes.

The Figure of the Plow.



The Staff is about two foot and an half long, or three foot at the most; at the Center end of which is erected a small Arch that is divided into 85 degrees; on the side of the Staff are set off the Graduations proper to the Plow, beginning at 5 deg. and increasing to 10 degrees towards the Arch, every degree divided actually into single minutes.

The Vanes are, a *Horizon* and *Shadow Vane*, (to be used as in the Quadrant), and a *Sight Vane* moving upon the Staff as at A.

The

The Use of the Plow.

This Instrument is contrived for a backward Observation of the Suns Altitude, after the manner of the Quadrant, therefore fit on your Horizon Vane, & place the Shadow Vane to a certain number of degrees, so that they may not exceed the Suns greatest Altitude like to be at the time of Observation, but be alwayes somewhat less, yet not so much less as that the difference be above 10 degrees, for in both these cases the divisions on the Staff (if not prevented) which prove useless; then put the Sight Vane upon the Staff, and bring the shade of the upper part of the Vane, to the upper part of the slit in the Horizon Vane, and look for the Horizon; but if instead thereof you see all Water, then withdraw the Sight Vane, and remove it towards the begining of the divisions; but if on the contrary you see all Skie and no Water, then move the Vane towards the Arch; and this you must reiterate, till the Shadow falling upon his true place, you see the Horizon exactly by the slit in the Horizon Vane, at the same time you have the Suns present Altitude; and if it be an Observation for the Latitude, then this last work must be repeated as often as you think fit, as in the use of the foregoing Instrument is already declared.

Sometimes upon the spare sides of the Staff belonging to the Plow, are divided the degrees and minutes proper to the Staff; and three Vanes or Crosses are accordingly fitted, whose use are in all respects the same with the Cross Staff, placing that end of the Plow where the Arch stands to your eye, and putting the Vanes (last described) on to the Staff (cross-wayes to the Arch) and turn the said Arch from your eye, that it may not hinder your Observation. What else might be said to the use of the Plow thus fitted, is already declared in the use of the Cross-Staff.

There is yet a further improvement of the Plow, whereby it is contrived to supply the place of two other Instruments, besides it own peculiar use, *viz.* the Cross-Staff and the Quadrant, without inconvenience or incumberance.

To accomplish this, there is a long Transum, E, F, D, four square, fitted to slide upon the Staff of the Plow; upon the outside of this Transum, are drawn seven cross lines, six of which are noted with the figures 30, 60, and 90, and one with the word Vane; upon the longer (which is the lower) part of this Transum are drawn several divisions, numbred with 510, *&c.* and proceeding to 20 degrees upwards

wards towards the Staff; likewise there is a Sight Vane (like that of the Quadrant) fitted to slide upon this Transum; the spare sides of the Staff, are divided into degrees and minutes, after the manner of the Cross-Staff: The use briefly follows.

1. *To use it as a* Plow.

Place on the Horizon and Shadow Vane as before, then sliding on the long Transum, with the Nut inward to the Archward, place the sight Vane D, to the line under the word *Vane*, on the said Transum, and then the use of it is the same with that formerly described.

2. *To use it as a* Quadrant.

The Horizon, and Shadow Vane, standing as before, and likewise the long Transum with the Nut inwards, place the said Transum to the letter Q, (on the side whereon the Graduations of the Plow stand) then bring the Sight Vane to your eye, and remove the same higher or lower upon the Transum, until the shadow falling upon the upper part of the open Sight in the Horizon Vane, you see the Horizon at the same time, then have you the Altitude, which is thus to be computed upon this Instrument, Cast your eye upon the Transum, see what degrees and minutes are cut by the Sight in the Sight Vane, to which add the degrees at the upper edge of the Shadow Vane, (using those divisions figured with 5, 10, *&c.* at the upper end of the Arch, to 85 at the lower end) the sum is the Complement of the Altitude, or the Suns distance from the Zenith.

3. *To use it as a* Jacob Staff.

The Transum being on the Staff, with the Nut inwards, remove the Shadow Vane, & place it on the upper part of the Transum on the outside, as the Sight Vane stands; take off the Horizon Vane, place that end to your eye, turning the Arch downwards, (which Arch does assist you in the holding your Instrument, and not at all hinder your Observation) and then the use hereof is the same with the Jacob Staff already described. The working your Observations shall be shown in the general Rules.

The Description and Use of an Instrument for Observation and Operation, called the Removing Quadrant.

The Description of the Removing Quadrant.

This is a good and useful Instrument in Navigation, and is of a convenient portability for stowage in a mans Chest, being it is to take all in pieces, and beareth its name from its use, one leg thereof being often removed in Observation.

The parts of it are first two pieces joynted with a brass joynt like a joynt rule, and will close together; and in the Center is a hole for the putting in the end of a Horizon Vane, marked with A.

There is also a great Arch marked with *d*, *e*, containing a Quadrant, or 90 degrees, divided into minutes by Diagonal Lines, being above an inch in breadth commonly. And also there is divided on the same Arch, the eight points of the Compass, with their halves and quarters.

One end of this Arch is fastned into one of the containing sides, with a brass Pin to take in and out at pleasure; on each of these containing sides is a Vane, one a Shadow Vane noted with B, and the other a Sight Vane denoted by C; the Shadow Vane is on that side where the Arch is put in and fastned, noted with *f*, *g*, and is to move up and down that side at pleasure, for the better and sharper striking the shadow upon the Horizon Vane; the other side marked with *b*, *i*, moveth upon the Arch: and on the end of this side is put the Sight Vane at *i*.

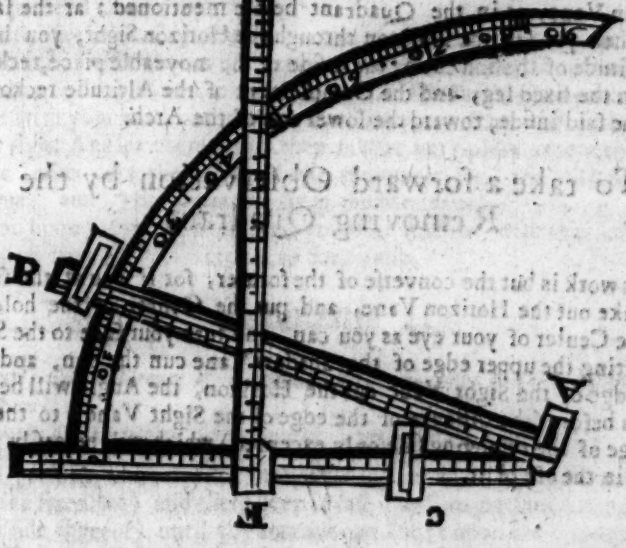
This Instrument is principally for a backward, but is also capable of a forward Observation; the degrees are numbred both wayes, and the Observation taken by this Instrument is very easie in Operation, and with very little trouble; for the degrees intercepted between the two containing sides, is the Altitude of the Sun, and the degrees contained from the Sight Vane to the lower end of the Arch, is alwayes the Complement of the Suns Altitude, be it taken either forward or backward.

This Instrument doth as plainly, and more exactly perform the work of the Sinical Quadrant in Navigation, and resolveth any question in any right angled Triangle.

For the performance of this work, the two containing sides are divided

vided into 60, and sometimes into any hundred equal parts, which you may call Leagues or Miles in the solving any Nautical Question; and there is also a long Index that is to have the same divisions on it, as on the containing sides; and this Index is made to move truly up and down upon the side, according to the nature of the Question, but alwayes to stand at right Angles therewith; the several Uses follow, and first for Observation.

The Figure of the Removing Quadrant.



To take a Backward Observation of the Sun, with the Removing Quadrant.

For the performance thereof, you must put first the Horizon Vane into the Center hole, where it is to turn round, so that you may turn the sight as open and as close as you will your self, so also that the Ho-

rizon Vane may receive the shadow from the Shadow Vane: next you must put on the two other Vanes, the Shadow Vane, and the Sight Vane; the Shadow Vane may be put any where upon the side where the Arch is put in and made fast, then you must put in the Arch into that side which is the standing part, and then you must pin it in, and also put the Arch through the other side, to move up and down in time of Observation, on which side, without the Arch, must be put on the Sight Vane; it being thus fitted, is ready for Observation.

Therefore turn your back toward the Sun, (in the same manner as you observe with the Sea Quadrant) and place the Instrument with the Sight Vane to your eye, and the Horizon Vane toward the Horizon, and the Shadow Vane to the highermost, then open the sides wider and wider, until you see the shadow of the Sun to fall upon the Horizon Vane, as in the Quadrant before mentioned; at the same time when you see the Horizon through the Horizon Sight, you have the Altitude of the Sun cut by the inside of the moveable piece, reckoned from the fixed leg, and the Complement of the Altitude reckoned from the said inside, toward the lower end of the Arch.

To take a forward Observation by the Removing Quadrant.

This work is but the converse of the former, for if you at the same time take out the Horizon Vane, and put the Center of the hole as near the Center of your eye as you can, and turn your face to the Sun, and letting the upper edge of the Shadow Vane cun the Sun, and the inner edge of the Sight Vane cut the Horizon, the Angle will be the same as before (the distance of the edge of the Sight Vane, to the inner edge of the removing side only excepted) which will be easily perceived in the use of it.

The Uſe of the Removing Quadrant in Operation, ſhewing the Reſolution of the uſual Problems in plain Sailing.

Probleme 1.

Courſe and diſtance being given to find the difference of Lattitude, and the departure from the Meridian?

Courſe the 6*th* Rhumb, diſtance 100 Leagues.

For the ſolving of this Queſtion by the Removing Quadrant, you muſt proceed thus.

Firſt, Set the inſide of the moveable leg to the Courſe given in the 6*th* Rumb, (which you will find upon the Arch of the Quadrant) then upon the ſaid leg look out 100 Leagues, ſet the Index thereunto, keeping it with your hand cloſe to the ſtanding part, (that the Index may be at right Angles therewith) then at that very place where the edge of the Index cuts the inſide of the moveable leg, you will find 92 Leagues, and $\frac{2}{12}$ the departure from the Meridian.

And upon the other fixed leg, you will find cut with the Index 38 Leagues, and $\frac{2}{12}$ the difference of Lattitude.

Probleme 2.

Courſe and difference of Lattitude being given to find the diſtance and departure?

Courſe 6*th* Rhumb, difference of Lattitude 38 Leagues $\frac{2}{12}$.

To perform this, ſet the moveable leg to the Courſe, (reckoned from the fixed leg) and there keep it faſt (by turning the Skrew on the under ſide thereof) until you remove the Index upon the fixed leg, to the difference of Lattitude 38 Leagues $\frac{2}{12}$; then the edge of the Index ſhall cut upon the moveable leg the diſtance run 100 Leagues; and upon the Index ſhall be cut the departure from the Meridian 92 $\frac{2}{12}$ Leagues.

Probleme 3.

Courſe and departure from the Meridian being given to find the diſtance run, and the difference of Lattitude?

Courſe 6*th* Rhumb, departure 90 $\frac{2}{12}$ Leagues.

For

For the working this Question, you must set the moveable leg to the Course given (*6th* Rhomb) from the fixed leg, and there keep it fast, untill by moving the Index to and fro on the fixed leg, the departure from the Meridian (found) upon the Index, where it doth just touch the inside of the moveable leg; then on the fixed leg the Index will cut 38 Leagues ½, *the difference of Lattitude*; and on the moveable leg you shall find, *cut by the Index*, 100 Leagues the distance run.

Probleme 4.

The distance run, and the difference of Lattitude being given to find the Course and departure from the Meridian?

Distance run 52 ½ Leagues, difference of Lattitude 20 Leagues.

To work this Question by the Removing Quadrant, set the Index to the difference of Lattitude, upon the fixed leg 20 Leagues, and there keep it fast, and then seek out the distance run upon the moveable leg 52 ½ Leagues, and put that very point to the edge of the Index, and there will be cut upon the Index 48 ½ Leagues the departure from the Meridian; and upon the Arch you will find cut, by the inside of the leg, the *6th* Rhomb, or 67 degrees 30 minutes.

Probleme 5.

The distance and departure being given to find the Course and difference of Lattitude?

Distance 108 Leagues, departure 90 Leagues.

To resolve this Question by the Removing Quadrant, find out the distance the Ship hath run upon the moveable leg, and then find out the departure upon the Index, which point is to be set to the distance found on the moveable leg, so the Index stands at right Angles with the fixed leg (which doth always represent the Meridian) being in this position, the edge of the Index shall cut the difference of Lattitude 60 Leagues upon the fixed leg; and also at the same time is cut by the inside of the moveable leg (upon the Arch) the Course the *5th* Rhomb from the Meridian, or 56° 15′.

Probleme

Probleme 6.

The difference of Lattitude, and the departure from the Meridian being given to find the course and distance?

Difference of Lattitude 60 Leagues (or 3 degrees) departure 90 Leagues.

To answer this Question by the removing Quadrant, seek the difference of Lattitude 60 Leagues on the fixed leg, and thereto set the edge of the Index, and then find out the departure 90 Leagues on the Index, unto which point set the moveable leg, and on the divisions thereof, by the edge of the Index, will be cut the distance run 108 Leagues, and upon the Arch will be found the Course, the 5*th* Rhomb from the Meridian.

Probleme 7.

To know how many Leagues you are to Sail upon any Point of the Compass, to alter one degree of Lattitude by the Removing Quadrant.

To perform this, you must set the edge of the Index to 20 leagues on the fixed leg, (so many leagues, making one degree in the Equinoctial) the Index being so set, doth represent the parrallel of Lattit. and then placing of the inside of the moveable leg unto the first Rhomb from the Meridian, you will find cut by the Index upon the moveable leg (which alwayes represents the distance run) the number of leagues which you are to run upon that Point of the Compass to raise one degree of Latitude, *viz.* 20 leagues 1 mile; and on the second Rhomb you will find it to be 21 leagues 2 miles; and on the third Rhomb 24 leagues; and on the fourth Rhomb 28 leagues 1 mile; and on the fifth Rhomb 36 leagues; and on the sixth Rhomb 52 leagues 1 mile; and on the seventh Rhomb 102 leagues 2 mile.

The departure from the Meridian is also given upon the edge of the Index at the intersection thereof, with the moveable leg, at every removing to the several Rhombs, as on the first Rhomb you will find it to be 4 leagues, on the second Rhomb 8 leagues 1 mile, on the third Rhomb 13 leagues 1 mile, on the fourth Rhomb 20 leagues, and on the

fifth

fifth Rhomb the departure is 30 leagues, and one the sixth Rhomb it will be 48 leagues 2 miles, and on the seventh Rhomb you will find the departure to be 100 leagues 2 miles.

Probleme 8.

To know how many miles answereth to one degree of Longitude in any Latitude, by the Removing Quadrant.

For the performance hereof, you must set the inside of the moveable leg to the Lattitude of the place found upon the Limb, reckoned from the fixed leg, and then removing the Index up and down on the fixed leg (at right Angles with it) until the edge of the Index doth cut 60 miles on the moveable leg; then at that time you may see how many Leagues is cut by the edge of the Index on the fixed leg, and those are the quantity of miles answering to one degree of Longitude in that Lattitude, as may appear by this

Example.

For the Lattitude of 51 degrees 30 minutes, I demand how many Leagues answereth to one degree of Longitude in that Lattitude?

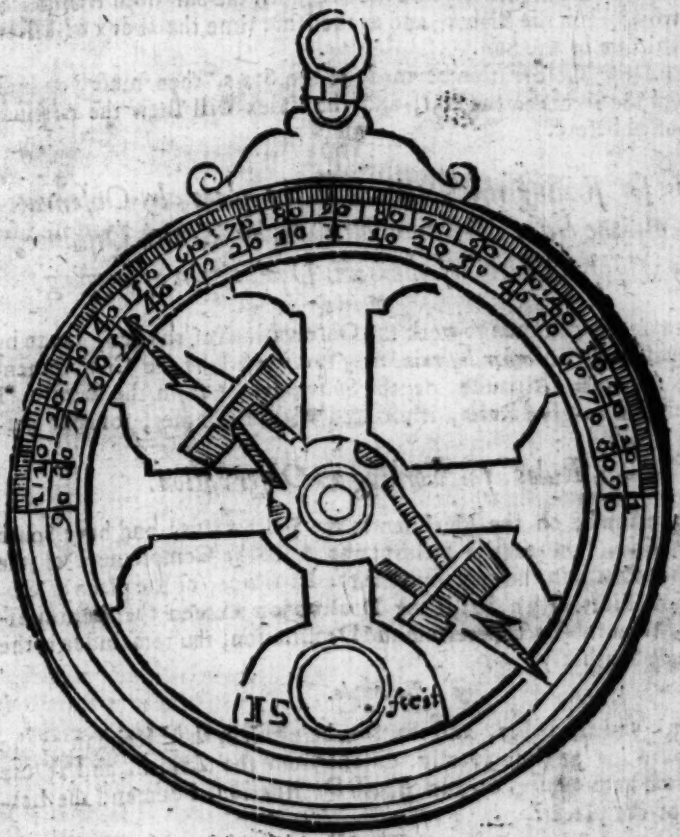
Therefore I first set the inside of the moveable leg to the Lattitude of 51° 30′ found on the Arch, counted from the fixed leg; then slide the Index upon the fixed leg, until the edge thereof doth intersect 60 on the moveable leg; then on the fixed leg you will find cut by the edge of the Index 37 ½ miles, shewing that in the Lattitude of 51° 30′, there must be 37 ½ miles to one degree of Longitude.

The Description and Use of the Astralobe.

This Instrument is of very antient invention and use, but principally by the *Spaniards* and *Portugals*; the matter whereof it is made is Brass, the form round, being very solid and ponderous, and is thereby the more fit for the Observations intended thereby; upon the convexity thereof is fitted a Ring and Swivel for to hang it upon your finger, or elsewhere, and to turn to any verticle position required; The Superfecies of this Instrument is divided into 4 quadrants, the two upper being

being divided into 180 degrees, both numbred from the Horizon toward the Zenith, with 10, 20, 30, &c. which are to shew the Altitude either of Sun or Stars; and upon the Center of the Instrument there moveth an Index with two Sights placed thereon, and in the midst of which there are two holes for the transpeircing of the rayes of the Sun, also for the beholding the Stars through them; but that it may be the better understood, I have hereunto annexed the Figure thereof.

The Figure of the Astralobe.



The Use of the Astralobe.

The use of this Instrument is chiefly to find the Altitude of the Sun and Stars, but of more principal use when the Horizon is obscured by mists, when other Instruments, *that respect the Horizon*, are rendred useless.

Therefore this Instrument being hung on your finger, or other convenient place, (and if it be for an Observation of the Sun) then you are to direct the Sights towards the Sun, until the Sun doth transpeirce the two holes in the Sights; and at the same time the Index will shew the Altitude of the Sun.

But if the Observation be made of the Stars, then must you look through the Sights to the Star, and the Index will shew the Altitude thereof as before.

Rules for finding the Lattitude of the place, by Observations of the Suns Meridian Altitude, or Zenith Distance, by help of the Table of the Suns Declination aforegoing.

Because 'tis common to work the Observations of the Sun, taken by the Quadrant, *and other Instruments (now in use)* by the Complement of the Meridian Altitude, or the Suns distance from the Zenith, I shall therefore give Rules, illustrated with Examples, for that purpose.

Rules for working an Observation.

If the Sun be on the Meridian to the Southwards, and have South Declination, substract the Declination from the Complement of the Meridian Altitude, the remainder is the Lattitude, (of the place of Observation Northerly) but if the Declination exceed the Zenith distance, then substract therefrom the Declination, the remainder is the Lattitude Southerly.

Example.

Admit you are at Sea, and the Sun being upon the Meridian to the Southward, is 37 deg. 30 min. distant from the Zenith, and at the same time hath 12 deg. 00 min. South Declination, I demand the Lattitude of the place?

The Work by Arithmatick.

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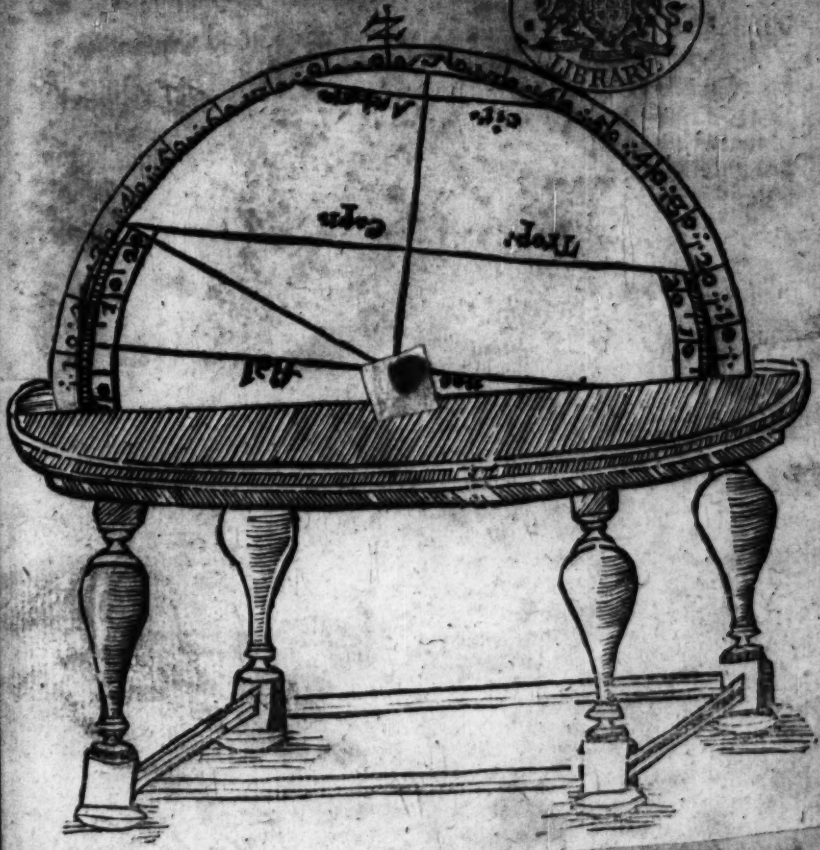

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Complement of the Meridian Altitude	57°	30′	
The Suns Declination, South, ſubſtract	12	00	
The Lattitude of the place,	45	30	North.

For the further illuſtrating of this, and the ſubſequent Examples, I have here annexed an Inſtrument, (although of Paper) which by the Altitude of the Sun, and his Declination given, ſhews the Lattitude of the place, and ſerves to demonſtrate the reaſon of theſe Rules, and how they naturally deduce themſelves from the Sphere.

The Figure of the Inſtrument.

In this Scheme, the undermoſt and fixed part, repreſents the upper Semi-circle of the Meridian, numbred upwards towards the Zenith, with 10, 20, to 90 degrees. The middle, and moveable part, is as it were a ſmall Planiſphere, or Analemma, having the uſual Circles and lines drawn thereon, *viz.* the *Equinoctial* and *Ecliptick*, the two *Tropicks* of *Cancer* and *Capricorn*; the *Artick* and *Antartick* Circles, and the Axis of the World, from the Equinoctial towards both Poles, are ſet the degrees of the Suns greateſt Declination, numbred with 10, 20, to 23° ½; the uppermoſt and fixed part repreſents the Horizon, and

reſembles that in the material Globes. In the uſe of this ſmall Inſtrument, you muſt obſerve theſe two directions.

1. That if you are in North Lattitude, you muſt apply the North Pole (ſignified by the Stars, and the word *Artick*, in the Scheme to the Semi-circle, denoting the Meridian, which ſhews (when uſed as ſhall be directed) the Lattitude of the place. In South Lattitude the ſame is to be underſtood of the South Pole, diſtinguiſhed by the name of *Antartick*.

2. For the avoiding of miſtakes, the Meridian is to be diſtinguiſhed into the North and South parts thereof, which are differenced by the Poles; for if the North Pole be elevated, then that part and quarter in which the Pole lies, repreſents the North part of the Meridian, and the other Quadrant the South part; the ſame is to be obſerved in South Lattitude.

The uſe of this Inſtrment is very facile, for placing the Suns Declination on the moveable part, to the Suns Meridian Altitude found on the fixed Semi-circle; the elevated pole ſhews the Lattitude of the place.

As in the Example before mentioned.

Let the Suns diſtance from the Zenith be 57 deg. $\frac{1}{2}$, the Complement 32 deg. $\frac{1}{2}$ is the Altitude, and the declination 12 deg. The Lattitude is required?

Being in North Lattitude, as is premiſed in the Example, elevate the North Pole, and bring the Suns Declination 12 deg. to the Altitude, 32 deg. $\frac{1}{2}$ on the South ſide of the Meridian Semi-circle, (*viz.* in the Quadrant oppoſite to that in which the Pole lies) at the ſame time is pointed out by the North Pole 45 deg. the Lattitude of the place.

Example, 2.

Admit in South Lattitude, that the Sun on the South part of the Meridian is 10 deg. diſtant from the Zenith, and the Declination 20 deg. 30 min. South, I demand the Lattitude of the place?

The Operation in Numbers.

The Suns Declination	20°	30′
The diſtance from the Zenith ſubſtract	10	00
The Lattitude	10	30 South.

The

The Operation by the Instrument.

1. Being in South Lattitude, and the Meridian Altitude 80 deg. elevating the South Pole, I place the Declination in 20 deg. ; to the Altitude 80 deg. and the South shews the Lattitude to be 10 degrees Southerly.

2. If the Sun be on the Meridian to the Southwards, and have North Declination, then add the Declination to the Zenith distance, the sum is the Latitude Northerly.

Example, 1.

Admit a Ship at Sea, and that the Sun on the South part of the Meridian is 30 deg. 30 min. from the Zenith, and that the Declination is 15 deg. 30 min. North, I demand the Lattitude?

Operation by Numbers.

The Complement of the Altitude or Zenith distance is	30° 30′	
The Declination added	15° 30′	
The Lattitude	46° 00′	Nor.

Operation by the Instrument.

Being in North Lattitude, the Suns Meridian Altitude 59 degrees ; I place the Declination 15 deg. ; North, unto 59 deg. , the Altitude on the South part of the Meridian, the Elevated Pole shews the Lattitude to be 46 degrees.

3. If the Sun be on the Meridian to the Northwards, and have North Declination, then subtract the Co-altitude or Zenith distance from the Declination, the remainder is the Lattitude Northerly; But if the Coaltitude exceeds the Declination, then subtract the Declination therefrom, the remainder is the Lattitude Southerly.

Example, 1.

Suppose the Declination were 20° North, and the Co-altitude 12° 30′, the Sun being upon the Meridian to the Northwards, I demand the Lattitude? Ope-

Operation by Numbers.

The Suns Declination North	20°	00′
The Co-altitude substract	12	30
The Lattitude of the place,	07	30 Nor.

By the Instrument.

Being in North Lattitude, and the Altitude 77° ½, I place the Declination 20° North, to Altitude 77 ½, on the North part of the Meridian Semi-circle, the Elevated Pole points out the Lattitude to be 7° ½.

Example, 2.

Suppose the Suns Declination to be as before, 20° North, and that being upon the Meridian to the Northwards, his Co-altitude is 40° 15′, I demand the Lattitude?

Operation by Numbers.

The Co-altitude of the Sun is	40°	15′
The Declination North substract	20	00
The Lattitude	20	15 South

By the Instrument.

Being in South Lattitude, bring the Declination 20° North to the Meridian Altitude 49° ½ on the North part of the Semi-circle, the South Pole shews the Lattitude to be 20° ½, or 15 min.

4. If the Sun be upon the Meridian to the Northwards, and hath South Declination, then add the Declination to the Co-altitude, the Sun is the Lattitude Southerly.

Example.

Admit the Suns Declination were 16° 45′ South, and the Co-altitude 29° 45′, I demand the Lattitude?

Operation

Operation by Numbers.

The Declination of the Sun South	16°	45′
The Co-altitude add	29	45
The Lattitude	46	30 South

By the Instrument:

Being in South Lattitude, place the Declination 16° ¾ South, to the Altitude 60° ¼ on the North part of the Semi-circle, the Elevated points out the Lattitude to be 46° ½.

5. If the Sun have no Declination, then the Complement of the Altitude is the Lattitude of the place; and if the Sun be on the Meridian to the Southwards, your Lattitude is Northerly, if to the Northwards, Southerly.

This needs no Example.

6. If the Sun be in the Zenith (*i. e.*) 90° above the Horizon, then the Declination either Northerly or Southerly is the Lattitude of the place. This likewise needs no illustration.

7. If you be within the Artick or Antartick Circles, and observe the Sun upon the Meridian under the Pole, then add the Suns Declination to the Complement of the Altitude, and the sum substract 180°, from the remainder is the Elevation of the Pole.

If your Instrument wherewith you observe, give only the Meridian Altitude, (as the Plow, or some other) then substract that Altitude from 90°, the residue is the Zenith distance, or Co-altitude of the Sun, and the Operation is the same as in the precedent Examples.

What hath here been delivered in these Rules concerning the Suns being upon the Meridian, the same is to be understood of any Star, whose declination is known.

Admit you should observe the bright Star *Arcturus*, whose Declination is 21° 19′ North. When he is upon the Meridian to the Southwards, and find his Altitude to be 65° 25′, the Complement hereof is 24° 35′, the distance from the Zenith or Co-altitude; then adding 21° 19′ to 24° 35′, the sum 45° 54′ is the lattitude Northerly according to the second Rule aforegoing.

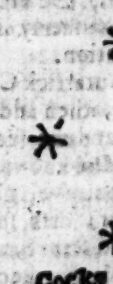
But

But if you observe by any of the Stars near the North Pole, and if they be on the Meridian under the Pole, add the Complement of their declination to the Meridian Altitude found, their sum is the Lattitude Northerly.

But if you observe any Star that is upon the Meridian above the Pole, then from the Meridian Altitude of that Star substract the Complement of his Declination, the remainer is the Lattitude Northerly; or if out of the Complement of the Stars Declination you substract his Meridian Altitude, the remainer is the Lattitude Southerly.

Here I thought it necessary to mention something of the Crossiers, which are certain Stars that are of great use in the Southern Navigations, and are so called, because they do somewhat resemble the form of a Cross, according to this annexed Figure.

The Figure of the Constellation, called the CROSSIERS.



The Star at C, is the principal Star for Observation, called the *Cocks foot*, whose declination is 30 degrees from the South Pole, (according to the judgment of Mr. *Wright*, in his *Correction of Errors*) where it is observed, that by knowing the greatest Altitude of this Star, your distance from the Equinoctial may be known; for if the Meridian Altitude of that Star be 30 degrees, then you may judge your self to be under the Equinoctial; and if the Altitude be less then 30, then are you so much to the Northward of the Equinoctial; but if

if the Altitude be greater by 30 degrees, by so much are you to the Southward of the Equinoctial.

And to know when the Star is fit for Observation, you may note, that when the said Star at C, and the Star at A is a perpendicular position, then may you assure your self, that the Star is upon the Meridian, and fit to be observed.

The Description and Use of the Nocturnal.

The Description of the Nocturnal.

This Instrument consists of three parts.

First, The broadest and greatest, which we may call the unmoveable part, which hath a handle to it to hold it in time of Observation.

Secondly, The first moveable or middle part.

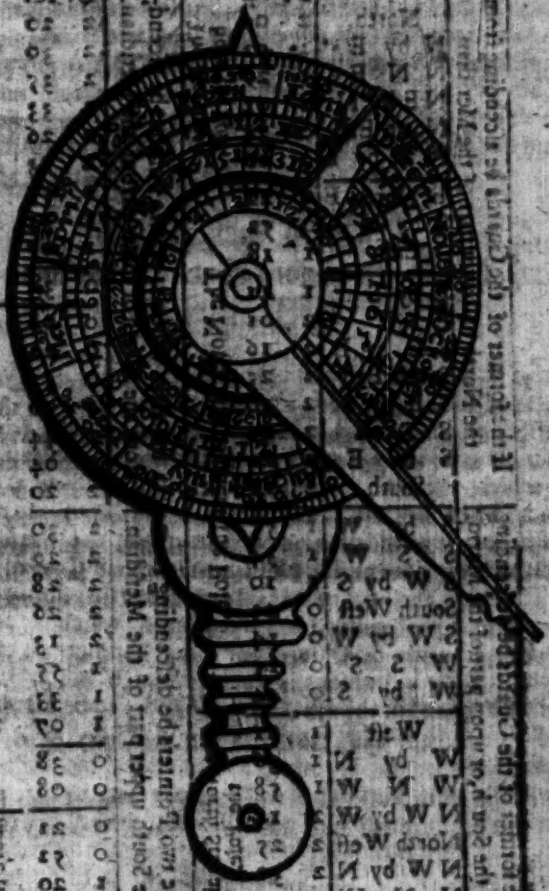
Thirdly, The long Index that is to turn to the position of those Stars for which they are made, (*i. e.*) the guards of the little or great Bear.

The forefide of the first or unmoveable part, hath the limb or outward Circle divided into twelve Months, and each month subdivided into its respective dayes, and are counted towards the left hand, and marked with their names, or the first letter thereof, as *J* for *January*, *F* for *February*, *M* for *March*, &c. And upon some of them there are two other Circles, the outermost of which is divided into 24 equal parts, or hours; and the other into 29 parts, or dayes of the Moons Age, by which the Moons Southing may be known (by inspection only) and thereby a computation of the Tides.

Of these Nocturnals, there are of two sorts, one for the Guards of Little, the other for the Guards of the Great Bear, or Charles Wain, commonly called the two Pointers. Now to know for which of these Constellations any Nocturnal is made: You may observe, that the Nocturnals that are for the Guards of the great Bear, hath the 17*th* of *February* on the top; and if it be for the Guards of the little Bear, then you will find the 21 of *April* there. The backside of this part is divided into 32 parts or Points of the Compass, which are to shew the bearing of the Guards, thereby to know what Declination the North Star hath upon any point of the Compass.

The Figures of the Stars, as they shew themselves in the Heavens, for which the Nocturnall are made.

The Figure of the Nocturnal.



Here followeth a Table for the Declination of the North Star, upon every point of the Compass the guards are upon, fitted for both sorts of Nocturnals.

	Points of the Compass.	For the guard of the Little Bear. D.	M.		For the guards of the Gr. Bear, or aftermost Wheels in Charles Wain, called the two Pointers. D.	M.	
If the former of the Guards be ascending from the North or lower part of the Meridian.	North.	2	09	The North is above the Pole.	2	20	Above the Pole.
	N by E	1	52		2	30	
	N N E	1	29		2	35	
	N E by N	1	02		2	33	
	North East	0	35		2	26	
	N E by E	0	06		2	13	
	E North E	0	22	The North Star is under the Pole.	1	55	
	E by N	0	52		1	33	
	East.	1	18		1	07	
	E by S	1	41		0	38	
	E S E	2	01		0	08	The North Star is under the Pole.
	S E by E	2	16		0	22	
	South East	2	25		0	52	
	S E by S	2	30		1	20	
	S S E	2	22		1	44	
	S by E	2	22		2	04	
	South.	2	11		2	20	
If the former of the Guards be descending from the South, or upon part of the Merid.	S by W	1	55		2	30	
	S S W	1	34		2	29	
	S W by S	1	10		2	28	
	South West	0	43		2	26	
	S W by W	0	14		2	13	
	W S S	0	15		1	55	
	W by S	0	44		1	33	
	West	1	11	The North Star above the Pole.	1	07	
	W by N	1	36		0	38	
	W N W	1	58		0	08	
	N W by W	2	14		0	22	Above the Pole.
	North West	2	25		0	52	
	N W by N	2	30		1	20	
	N N W	2	29		1	44	
	N by W	2	22		2	04	

If the aftermost Wheels, or two Pointers be ascending from the North or lower part of the Meridian.

If the two Pointers be descending from the South upper part of the Meridian.

The

The manner of holding the Nocturnal in time of Observation.

Take the handle in your hand, with the forside toward you, holding of it upright in your hand, (which you may discern by the tip that is on the very top of the Nocturnal, and your eye will be sufficient to guide it) then looking through the hole in the Center to the North Star, then you must turn the upper edge of the Index (which cometh from the Center) to the Guards; this being understood, you may now proceed to the several uses thereof.

To find the hour of the Night by the North Star, and the Guards either of the Little or Great Bear.

To perform this, you must first set the Index of the 2nd & moveable part, to the day of the month (then if it will not stay of it self, you must stay it with your thumb) holding of it as you are before directed; find the North Star through the hole, and turn the Index to the Guards, and then upon the second, or moveable part, the edge of the Index shall cut the hour of the Night; at the same time you will find on the back side what Point of the Compass the Guard is upon, so that you might know also what declination the North Star hath at that time, either above or under the Pole.

To find the time of the Moons coming to South any day of her Age, and also the time of high Water that Day.

First, Find the Moons Age on the unmoveable part, and right against it, *in the Circle of Hours*, you will find the time of the Moons Southing.

As for Example.

Suppose the Moon were eight dayes old, I demand the time of her coming to South?

There-

Therefore look for 8 on the Circle of her Age, and right against it you will find in the hour Circle, almost half an hour past six of the Clock *in the evening* (because that always between the change and the full, she cometh to South in the Evening, but after the full, she cometh to South in the Morning) so having found the Moons Southing, if you add thereto the hour of the flowing at any place, you will then you the time of high Water there.

Suppose that here at *London* the Moon being 8 dayes Old, I find by the Nocturnal, that the Moon cometh to South at almost half an hour past 6 of the Clock; to which I add three hours, the time of high Water at the full and change, which being added to 6 a Clock 24 minutes, make 9 of the Clock 24 minutes, or almost half an hours, the time of high Water at *London* the 8 day of the Moons Age.

And if those numbers being added together should exceed 12, that 12 must be substracted from it, and that will be the time of full Sea. As suppose the Moon should be 13 dayes Old, at which time I find by the Nocturnal that the Moon cometh to South at 10 of the Clock, and 22 minutes past, or almost half an hour, unto which if you add 3 hours 24 minutes, from which if you take 12, there remaineth 1 of the Clock and 46 minutes, or almost half an hour, the time of high Water.

The description and use of the Horizontal Dials that are commonly made for Pocket Sun Dials.

These Dials do consist of two parts, one moveable, and the other unmoveable; on the unmoveable part are two Circles; on the uttermost is placed the Age of the Moon, on the innermost the 24 hours of the night and day.

The other is the moveable part, which also hath a circle of hours, and an Index issuing from the edge there, which upon occasion is to be turned to any day of the Moons Age required; and sometimes on the Plate are five Aspects with which the Moon doth respect the Sun, according to the Quantity of her seperation in Signs, as you may see in this annexed Table.

The

The Figure of the Moons Dial.

Characters	Names of the Aspects	Dist.
☌	Conjunction,	0 00
⚹	Sextile,	3 00
□	Quartile,	4 00
△	Trine.	6 00
☍	Opposition.	6 00

To find the time of high Water in any place,

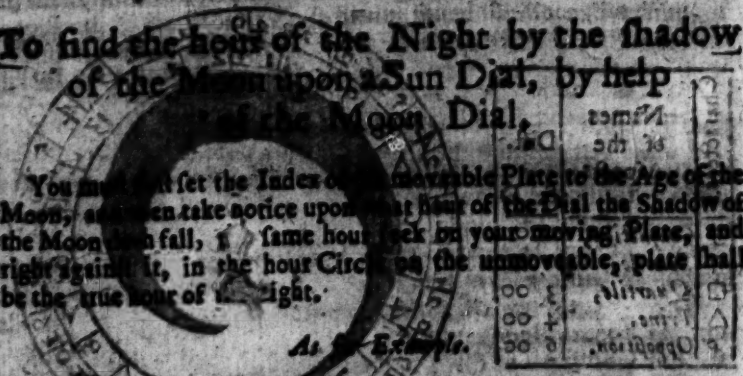
(the hour of full Sea at the full and change of the Moon) being known.

For the performance of this, the Age of the Moon must be known, by which you must set the Index of the moveable Plate, which having done, look the hour of high Water at the full and change on the immoveable Plate, and right against it, in the hour circle, on the moveable Plate, shall be found the time of high Water that day.

Suppose at *London Bridge* I would know what time it is high Water when the Moon is 3 dayes old: I therefore set the Index of the moveable Plate to 3 in the Circle of the Moons Age; and then because it is high

high Water at 3 of the Clock, on the full and change day at *London Bridge*; therefore I look against the hour of 3 in the moving Plate, and right against it I find the figure 7 in the hour Circle on the unmoveable Plate, which is the time of high Water.

To find the hour of the Night by the shadow of the Moon upon a Sun Dial, by help of the Moons Dial.



You must first set the Index of the moveable Plate to the Age of the Moon, and then take notice upon what hour of the Dial the Shadow of the Moon doth fall, & same hour seek on your moving Plate, and right against it, in the hour Circle on the unmoveable, plate shall be the true hour of the night.

As for Example.

Suppose the Moon were 17 dayes Old, and I see the shadow of the Moon to fall upon the hour of 10 on the Sun Dial, therefore I set the Index of the moveable Plate, to 17 in the Circle of the Moons Age; and right against the hour of 10, on the moveable Plate (which was the shadow of the Moon upon the Dial), shall be cut 11 and 36 minutes, or somewhat more then half an hour, which is the true hour of the Night.

If the moveable Plate be divided with the Aspects upon it, then it is thus to be used.

You are to take notice, that the place of the Sun is represented by that Point where the Age of the Moon beginneth, just at the place of the Conjunction of the Sun and Moon, which is in the Circle of the Moons Age, on the unmoveable Plate; therefore if you would know what Aspect the Moon hath to the Sun, you must set the Index of the removing Plate to the Age of the Moon, and then at the point of Conjunction, you will see what Aspect cutteth it, (for the Character of the Aspect is grav'd upon the line of correspondence) as if you turn the Index to 3 dayes and an half of the Moons Age, you will find that the correspondent point of the Sextile Aspect, will cut the point of Conjunction; and if you turn the Index to the seventh day of the Moons Age, you will find that the Correspondent part of the Quartile Aspect will cut the point of Conjunction. And the same way you may proceed in the rest.

To

To know when the Moon cometh to South by the Moon Dial.

First, Set the Index of the moveable Plate to the Age of the Moon, in the Circle of the Moons Age; which being done, look right against 12 in the moveable Plate, and there shall be cut, on the hour Circle (of the unmoveable Plate) the time of the Moons coming to South.

As suppose the Moon were 24 dayes old, unto which I set the Index, and right against 12 in the hour Circle, shall be cut 7 a Clock and 12 minits past, or almost a quarter in the morning, because the Moon is past the full.

So also you may know how old the Moon is at any time, by knowing the time of her coming to South, which is onely the converse of the former.

The Description and Use of the plain Scale.

This Instrument is very useful for the protracting the Problems of Navigation, and those Problems which are wrought by Arithmatick: This Instrument doth plainly demonstrate, for the livelier representation of the nature of the Question, the better to inform the judgment.

The Lines on this Scale are four in number, *viz.* the lines of *Chords*, *Rhombs*, *Leagues*, and *Longitude*; The Original projection of these lines are fully described in the former part of this Book, *Chap.* 2.

The Use of these Lines.

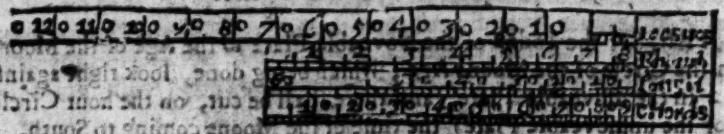
1. The line of *Chords*, setteth off, and measureth any quantity of degrees, in the Arch of a Circle, of the same Radius with the Scale.

2. The line of *Rhombs* is to set off any Rhomb or Point of the Compass, according to the nature of the line of Chords.

3. The line of *Leagues*, is to set off, or to measure any distance run upon any Course.

4. The line of *Longitude* is so proportioned, that it will discover the quantity of miles, that maketh one degree of Longitude in any Lattitude.

The Figure of the plain Scale.



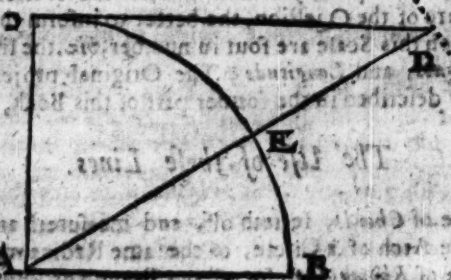
The farther use of these lines shall here be demonstrated in sundry Problems in Navigation, both according to the plain and true (commonly called *Mercators Chart.*)

Problems of the plain Chart.

Probleme I.

A Ship sailing upon a North East and by East, Course 108 Leagues, I demand her difference of Latitude, and the departure from the Meridian?

Illustrated by this following Diagram.



First, Draw the line A B of a convenient length, then on the point A, erect a perpendicular, as the line A C; then with the Radius of your Scale draw the Arch C B, and set off the Rhomb given, North East

East and by East, which is the fifth Rhomb, (taken off the line of Rhombs) and set it from C to E, then take the distance 108 Leagues off the line of Leagues, and set one foot of the Compasses in the point A, and draw a small occult Arch of a Circle as at D, then lay a Ruler upon the points A and E, and draw the line A E D, and from the point D draw a line parrallel to A B, as the line C D, which is the departure from the Meridian, which being measured upon the line of leagues, you will find to be 90, and A C you will find to be 60, which is the difference of Lattitude.

Probleme 2.

A Ship sail upon the North East by East Point of the Compass, until she alter her Lattitude 60 Leagues or 3 degrees, I demand what distance she hath run, and how much she hath departed from the Meridian?

Having drawn the Quadrant in the foregoing Scheme, according to the directions in the foregoing Probleme, set off the Course given from C to E, then set off 60 Leagues the difference of Lattitude given from A to C, then from the point C draw a line parrallel to A B, as the line C D, then laying a Ruler upon the point A and E, and where it toucheth the line C D, note the point of intersection, from which point extend the Compasses to the point C, which extent being measured upon the line of Leagues, will shew you 90 the departure required; then to find the distance run, extend the Compasses from A to D, which being measured in the line of Leagues, will shew you 108 the distance sought.

Probleme 3.

Suppose a Ship sail upon the North East and East Point of the Compass, until she hath departed from the Meridian 90 Leagues, I demand her distance run, and her difference of Lattitude?

Therefore having drawn the Quadrant A B C, as in the foregoing Diagram, set off the Course from C to E, and then draw the line A D through the point E, then take the departure from the Scale of leagues, which is 90, and set one foot of the Compasses about the point D, and move it there too and again in the line A D, until you have the nearest distance to the line A C, which will be just at D; then from the point D draw a line parrallel unto A B from the point D, and extend the

Compasses from the point D, unto the point A, that extent measured upon the line of Leagues, will give you the distance required, which is 108 Leagues; and where the line C D doth intersect the line C A, in the point C, the extent from C to A being measured upon the line of Leagues, will give you 60 Leagues the difference of Lattitude, which was also required.

Problem 4.

Suppose a Ship sail 108 Leagues, until she alter her Lattitude 60 Leagues, I demand the course and departure from the Meridian?

For the answering of this question, you must draw the Quadrant A B C, and then take the extent of the distance run from your Scale of Leagues, and set one foot of your Compasses in the point A, and with the other draw the small Arch of a Circle as at D; that being done, take from the Scale of Leagues, the difference of Lattitude, which is 60 Leagues, and set that off from A to C; then from the point C, draw a line parrallel to A B, as the line C D; and where it doth touch that small Arch D, that is the point of intersection, therefore extend the Compasses from the point D to C, and that extent measured upon the Scale of Leagues, will give you the departure from the Meridian; then draw a line from A to D, and there where it toucheth the Arch C B, as in the point E, is the course; therefore extend your Compasses as in the point E to C, and that distance being measured in the line of Rhombs, it will reach to the fifth Rhomb, which is the solution of the Question.

Problem 5.

Suppose a Ship sail 108 Leagues, until she hath departed from the Meridian 90 Leagues, I demand her course and difference of Lattitude?

After you have drawn the Quadrant, take the distance given from the Scale of Leagues; and then setting one foot of the Compasses in the point A, and with the other foot draw the small Arch D, then take out of the Scale of Leagues, the departure, which is 90 Leagues; and then setting one foot of the Compasses in the point C; and where the other foot doth touch the said small Arch, from that very point draw a line parrallel to A B, then the distance between C and A, is the difference of Lattitude, which measured upon the Scale of Leagues, will

give

give you 60 Leagues; the answer required, now to find the Course, do thus, from the Center A to the point D, draw a line, and where the said line doth intersect the Arch, that is the course, being measured from C to E, and laid upon the line of Rhombs, it will reach to the fifth Rhomb from the Meridian, which is the answer of the Question.

Probleme 6.

Suppose a Ship sails upon several Courses between the North and the East until she hath altered her Latitude 60 Leagues, and departed from the Meridian 90 Leagues, I demand her true course she hath made, and her distance from the place from whence she departed?

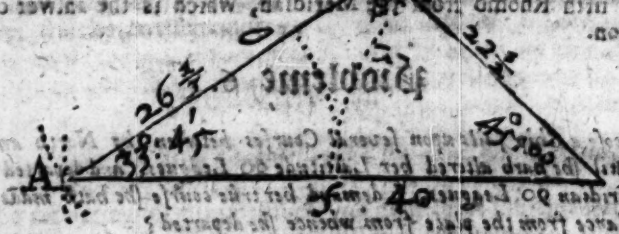
After the Quadrant is drawn, set off the difference of Latitude upon the line A C from A to C; then from the point C, draw a line parrallel to A B, and set off upon that line the departure, as from C to D, then the distance from D to A is the question sought, which being measured upon the line of Leagues, you will find it to be 108; also draw the line A D, and where the said line toucheth in the Arch C B, is the Course; which being measured upon the line of Rhombs, will give the fifth Rhomb, which is the true course the Ship hath made.

Probleme 7.

Suppose the bearing of two Ports be S W by S, and N E by N, distance 40 Leagues, and that a Ship sails from the Northermost of them South, and then West by South, sometimes upon one Point, and sometimes upon the other, until she arrive at the Southermost Port, I demand how many Leagues she hath sailed upon one course, and how many upon the other?

In this following Diagram, let A represent the Northermost Port, and E the Southermost, A E their Distance, A D the Leagues sailed upon the South Point, D E the Leagues sailed upon the West and by South.

Therefore



Therefore in the Triangle A D E, there is given the side A E 40 Leagues, and the Angle at A, contained between the South, and the South West by South 33° 45', and the Angle at D 45° 15' contained between the two courses; and the Angle at E is the Complement of the other two unto 180°, *viz.* 45', and there is required the sides A D and E D.

Therefore for the solution of this Probleme by the plain Scale, first draw the line A E, taking 40 leagues from your Scale, and set that distance off from A to E, (the distance of the two Ports) which line doth also represent the South West and by South, and the North East and by North Rhomb; then the Ship at A sails away South, until she arrives at D; therefore taking the Radius of your line of Chords, and setting one foot of your Compasses in the point A, draw the Arch *f g*, and take off five points from the line of Rhombs, and set it from *f* to *g*, and by the points A and *g*, draw the occult line A *g*, then set off the Angle at E 45 degrees, by the occult Arch of *f h*; then draw the line E D to the intersection at D, then draw A D, which measured in the line of Leagues, will be found to be 26 ¾ Leagues, and D E 22 ½ Leagues.

Probleme 8.

There are two Islands that bear East and West, and are distant from each other 40 Leagues; a Ship sails from the Easternmost North West by West, and then sailing 22 ½ Leagues further upon another course, arrives at the Westermost Port, I demand the distance sailed upon the first Course,

and

and the Course steered from the second place to the Northermost Island?

Therefore in the precedent Triangle A D E, let A represent the Eastermost Island, and E the Westermost, D the place where the Ship altered her course: Then in the said Triangle, there is given A E the distance of the two Islands 40 Leagues; the Angle at A, between the West, and South West by West 33° 45′, and E D the Leagues sailed; in the second course 22½ Leagues, and there is required D A the distance on the South West and by West point, and the Angle at D, whereby the second course is given, being an Angle contained between the first and second point steer'd.

Therefore for the solution of this Probleme by the plain Scale, first draw the line A E 40 Leagues, and upon the Point A, describe the Arch *f g*, and set off 33° 45′ from A to *g*, the Course of the Ship from the Eastermost Island; then draw the occult line A *e*, and then take off 22½ from your Scale of Leagues, and set one foot in E, and where the other foot doth touch in the occult line A *e*, which is at D, that is the place where the Ship altered her course; therefore extend your Compasses from the point D unto A; that extent being measured upon your Scale of Leagues, will give you 26½, and draw the line D A, then upon the point E, describe the Arch *f h*, which being measured in the line of Chords, will be found to be 45 degrees, which being added to the Angle at A 33° 45′, is 78° 45′, which being subtracted from 180 deg. leaves 101 deg. 15 min. the Angle at D.

Probleme 9.

Two Ships set sail from a certain Island bound for two several Ports, one steers away East by North 22½ Leagues, the other North East by North 40 Leagues, and arrive at their respective Ports, I demand the bearing and distance of these Ports?

In the foregoing Triangle, let E represent the Island, D the Southermost, and A the Northermost Port.

Then in the said Triangle A D E, there is given the Angle at E, contained between the East by North, and the North East by North is 45 deg. 00 min. E D the distance to the Southermost, and E A the distance to the Northermost Port; and there is required the Angles at A or D, to find the bearing, and the side A D, the distance of the said Ports.

Therefore first draw the line A E, and upon the point E describe the Arch *f h*, and set off 45 deg. from *f* to *h*, from E set off 40

Leagues

Leagues to A the distance sailed by one of the Ships, and set off 22 ½ Leagues to D, and draw the line E D, and from the points A and D, draw the line A D, which being measured on the Scale of Leagues, will be found to be 26 ½ Leagues the difference between the said Ports; and upon A describe the Arch *f g*, which being measured upon the line of Chords, will be found to be 33 deg. 45 min. the Angle contained between the South, and South West by South, which shews the bearing between the said Ports to be North and South.

Probleme 10.

A Ship bound to Sea sails South South East 22 ½ Leagues, and then 26 ½ more Easterly; but by foul Weather is forc'd back again to the Port from whence she set sail 40 Leagues; I demand what Course she steered from the second place to the third, and how she sail'd back again?

In the foregoing Triangle, let E represent the Port from whence the Ship set sail, D the place where she altered her Course, A the place from whence she was driven back again. Then in the Triangle A D E, there is given E D the distance sailed upon the South South East point 22 ½ Leagues, D A the distance in the second Course 26 ½ Leagues, and A E the Leagues she was forc'd back, *viz.* 40; and there is required the Angles at D and A, whereby the Courses are easily computed.

Therefore for the solution of this Probleme, draw the line E D 22 ½ Leagues from E to D, then take the distance 26 ½ Leagues; and so setting one point of the Compasses in D, describe the small occult Arch at A, then take the distance E A 40 Leagues, and from the point E intersect the former occult Arch in A; then draw the sides A E and A D, then upon the points A and E, describe the Arches *f g* and *f b*, which are the measure of those Angles at A and E, *viz.* A 33° 45′, and E 45°; the sum of which being substracted from 180 degrees, leaveth the Angle at D 101° 15′, which shews the course from D to A to be East and by North, and from A to E, West North West.

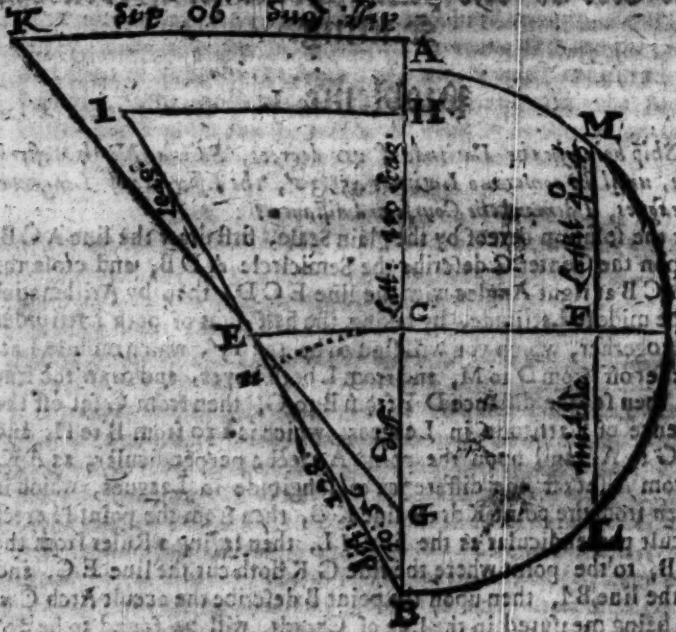
The

The Use of the plain Scale in Mercators Sailing.

Probleme I.

A Ship being in the Latitude of 40 degrees, Sails a North Westerly Course, until she come into Latitude 45° 30′, the difference of Longitude 90 Leagues, I demand the Course and distance?

For the solution hereof by the plain Scale, first draw the line A C B, and upon the Center C describe the Semicircle A D B, and cross the line A C B at right Angles with the line E C D; then by Arithmatick find the middle Lattitude, by taking the half sum of both Lattitudes added together, which you will find to be 42° 15′, which middle Lattitude set off from D to M, and from L both wayes, and draw the line M L, then set the distance D F from B to G, then from G set off the difference of Lattitude in Leagues, which is 210 from B to H, and from G to A, and upon the point A erect a perpendicular, as A K, and from A set off the difference of longitude in Leagues, which is 90, then from the point K draw line K G, then from the point H erect an occult perpendicular as the line H L, then laying a Ruler from the point B, to the point where the line G K doth cut the line E C, and draw the line B I, then upon the point B describe the occult Arch C n, which being measured in the line of Chords, will be found to be 30° 56′, which is the Course required, North West by North 02° 46′ Northerly, and the line B I is the distance required, which being measured upon the line of Leagues, will be found to be 128 Leagues.



Probleme 2.

A Ship being in the Lattitude 40° North, sails North West and by North 2° 49′ Northerly, until she comes into the Lattitude of 45° 30′, I demand the distance run, and the difference of Longitude?

In the solution of this Probleme by the plain Scale, draw the line A B at any convenient length, and upon C describe the Semi-circle A D B, and find the middle Lattitude as before, and set it off from D to M and L, and draw the line M L, and upon the point B describe the obscure Arch C *n*, and set off the Course given (which is 30° 56′) from C to *n*, and set the distance C F from C to G, and from B set off the difference of Lattitude in Leagues, which is 119 Leagues; and the same distance from G to A, and from the points H and A, erect

the

the two perpendiculars H I and A K, then through the point N draw the line B I, which being measured in the Scale of Leagues, will be found to be 128; then laying a Ruler from G to the intersection of the lines at E, draw the line G E K, and note where it intersecteth the line A K, which is at K, so the distance A K being measured upon the Scale of Leagues, will be found to be 90, the difference of Longitude sought.

Probleme 3.

A Ship being in the Latitude of 40° North sails between the North and the West, until she arrive to the Latitude 45° 30', and that her distance run be 128 Leagues, I demand the Course and difference of Longitude?

For the solution of this Probleme, first draw the line A C B at any convenient length, and upon C describe the Semi-circle A D B, and set off the middle Latitude as before, and likewise the distance C E from C to G; also the difference of Latitude in Leagues from B to H, and from G to A, then erect the two perpendiculars at H A, then take the distance between the Compasses, and set one foot of the Compasses in B, and extend the other foot towards I, until it doth intersect the perpendicular at H in the point I, then laying a Ruler upon the point G, unto the intersection of the lines at E, and draw the line G K, and note where it doth intersect the perpendicular at A, which will be at K, then the distance K A being measured on the Scale of Leagues will be found to be 80 the difference of Longitude sought; then for the finding the Course, with the Radius of your Scale draw the obscure Arch C n, and where it doth intersect the line B I, that distance being measured in the line of Chords, will be found to be 38° 56' the Course required, which is North West and by North 38° 56' Northerly.

Probleme 4.

A Ship being in the Latitude 40° North, sails North West by North 91° 30' Northerly 128 Leagues, I demand the Latitude of the second place, and the difference of Longitude?

For the solution of this Probleme, first draw a line B A of any convenient length, then from one end thereof, as B, describe the occult Arch C n, and set off 38° 56' from C to n, then by the point n, draw the line B I, the distance 128 Leagues, and from the end thereof, as at I, let fall the perpendicular I H, then measure the distance H B, which

you will find to be 110 Leagues, or 05° 30′ the Latitude of the second place; then having the two Latitudes, find the middle Latitude, as is before directed; then upon the line B A and upon the Center C, describe the Semi-circle B D A, and drawing the line D E from the point D, set off the middle Latitude 42° 45′ both wayes of M and L, and draw the line M L, then take the distance D F in your Compasses, and set it off from B to G, and from H to A, then upon the point A, erect an occult perpendicular, as M K, then by the point E, draw the line G K, till it intersect the perpendicular at K; then draw A K, which being measured in the line of Leagues, will be found to be 90 Leagues, or 04° 30′ the difference of Longitude required.

Probleme 5.

A Ship being in the Latitude of 48°, sails in that parrallel, until her difference of Longitude be five degrees, I demand her distance run?

This Question is usually demonstrated amongst the Problemes of *Mercators* sailing by a Scheme drawn for that purpose, and differing from that already described, but we shall here shew the way how to resolve this Probleme, by the help of the line of Longitude on the plain Scale only.

It is to be understood, that according to the Globe the Meridians do incline nearer together, until they concur and intersect each other in the Poles, so that thereby the degrees of Longitude are not 60 miles in any parrallel on the North or South side of the Equinoctial; but the nearer to either of the Poles you approach, the more they decrease, so that in the Latitude of 60 degrees, there are but 30 miles to one degree of Longitude, and in the Latitude of 84 degrees, there is but 6 miles, which doth plainly refute the errors of the plain Chart; and therefore in sailing, there ought to be respect had to the rectifying thereof according to the Globe, and to that end in demonstrative operations by the plain Scale, was this line of Longitude contrived, which is thus to be used, if you desire to know how many miles there are in any degree of Longitude in any Latitude.

You must extend the Compasses from the Center in the line of Chords, to the degrees of the Latitude of the place, and the same extent will reach from the Center at 60, on the line of Longitude to the number of miles answering to a degree of Longitude in that Latitude.

There-

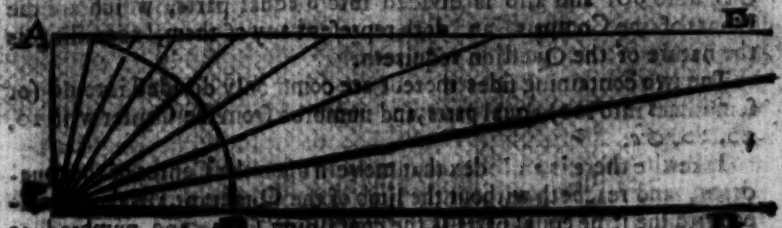
Therefore for the solution of the fifth Probleme here proposed, extend your Compasses upon the line of Chords, from the Center to the Latitude of the place, which is 40′, the same extent will reach from the Center at 60 (in the line of Longitude) to 46, which shews that 46 miles maketh a degree of Longitude in that Latitude, which 46 being multiplyed by 6, the degrees of Longitude gives 276 miles, or 92 leagues, which is the distance run which was required.

Probleme 6.

A Ship being in the Latitude of 40 degrees, sails in that parrallel 272 miles, I demand her difference of Longitude?

For the solution of this Probleme, find how many leagues make a degree of Longitude in the Latitude of 40 degrees (as in the last Probleme) which is 46, therefore if you divide 272 miles the distance run, by 46 (the miles in a degree of Longitude in that Latitude) the quotient will be 6 degrees, the difference of Longitude required.

To know how many Leagues you must sail upon any Point of the Compass, to raise one degree of Latitude, demonstrated by the plain Scale.



First, Draw the line C B D, and upon C erect a perpendicular as C A (then because 20 leagues maketh one degree in the Equinoctial) take 20 leagues, and set off from C to A, (and if your Scale of leagues be too small, you may double it) then describe the Arch A B, and divide it into 8 equal parts, (which are the points of the Compass) and draw lines through each respective point until they touch the line

A E,

A E, then each of these lines being measured upon the Scale of leagues, will give you the distance you are to sail upon each point, as upon the first Point you will find 24 leagues 1 mile; on the second, 10 leagues 2 miles; on the third, 24 leagues; upon the fourth Rhomb, 28 leagues 2 miles; upon the fifth, 36 leagues; upon the sixth, 52 leagues 1 mile; and upon the seventh, 100 leagues; on the eighth point, you neither raise nor lay the Pole at all.

The departure from the Meridian you may also find upon the line A E, on every respective point taken from it.

As for the first Point, you will find 4 leagues; on the second 8 leagues 1 mile; and on the third you will find 13 leagues 1 mile; on the fourth, 20 leagues; on the fifth, 30 leagues; on the sixth, 48 leagues 1 mile; on the seventh, 100 leagues.

The Description and Use of the Sinical Quadrant.

The Description of the Sinical Quadrant.

This Instrument is commonly made of Brass, Box, or Peartree, being a Quadrant, or fourth part of a Circle, the limb thereof being divided into 90 equal parts or degrees, is numbred with 10, 20, 30, 40, *&c.* unto 90, and also is divided into 8 equal parts, which are the Points of the Compass, and doth represent any of them, according as the nature of the Question requireth.

The two containing sides thereof are commonly divided into 60 (or sometimes into 100) equal parts, and numbred from the Center with 10, 20, 30, *&c.*

Likewise there is an Index that moveth upon the Center of the Quadrant, and reacheth without the limb of the Quadrant, [illegible] with the same equal parts as the containing sides, and numbred as before.

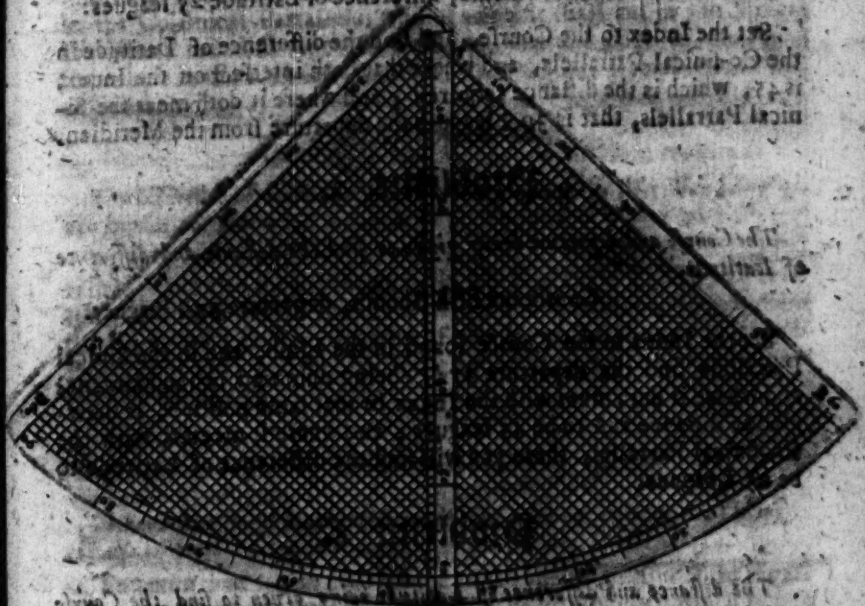
And from those equal parts on the sides, are drawn parrallels throughout the whole Superfecies of the Quadrant, crossing one another at right Angles.

And the lines of the sives and tens are commonly [illegible] [illegible] sake, which said lines and parrallels do represent the lines, and sine Complements of any Arch, (divided into equal parts) [which I suppose is the [illegible] is called a *Sinical Quadrant*.]

But

But here note, that those parallels that proceed from the side A B, (in the figure of the *Sinical Quadrant*) are for distinction called *Sinical Parallels*; and those Parallels that proceed from the side C D, are called *Co-sinical Parallels*. Now these directions being observed, we shall proceed to the use, or the Solutions of several Problemes in Navigation, and in working a Traverse at Sea, &c.

The Figure of the Sinical Quadrant.



The Use of the Sinical Quadrant.

Probleme I.

The Course and distance being given, to find the difference of Latitude, and the departure from the Meridian.

Course the fifth Rhomb, distant 45 leagues.

There-

Therefore first put the Index to the fifth Rhomb, which being done find the distance given upon the Scale, which is 45 leagues; and in the Sinical parrallels, you will find the Index to cut 25 leagues, which is the departure; and in the Co-sinical Parrallels, it will cut 39 ½, which is the difference of Latitude.

Probleme 2.

Course and difference of Latitude being given, to find the distance run, and departure from the Meridian.

Course the fifth Rhomb, difference of Latitude 25 leagues:

Set the Index to the Course, and find the difference of Latitude in the Co-sinical Parrallels, and where that doth interfect on the Index, is 45, which is the distance required; and where it doth meet the Sinical Parrallels, that is 39 ½ leagues the departure from the Meridian.

Probleme 3.

The Course and departure being given to find the distance and difference of Latitude.

Course the fifth Rhomb, departure 39 ½ leagues.

Set the Index to the Course found in the Limb, and in the Sinical Parrallels find the departure 39 ½, (being numbred in the Margent) and where it doth meet with the Index in that same position, it sheweth the distance run to be 45 leagues; and where it meeteth with the Co-sinical Parrallel, there you will find the difference of Latitude to be 25 Leagues.

Probleme 4.

The distance and difference of Latitude being given to find the Course and departure.

Distance 45, difference of Latitude 25 Leagues.

First, Find the distance run upon the Index, and then move the Index until it doth interfect in the difference of Latitude in the Sinical Parrallels; and at this position of the Index, look in the limb, and there you will find the Course to be the fifth Rhomb, which was required,

quired; and where the Sinical Parrallel of 25 doth meet with the Co-sinical Parrallel under the edge of the Index, that will shew you the departure from the Meridian, which is 37½ Leagues, (which you will always find in the Margent on the side C D.)

Probleme 5.

The distance run, and departure from the Meridian being given, to find the course and difference of Latitude.

Distance 45 Leagues, departure 37½ Leagues.

First, Find the distance run on the Index, put that to the departure in the Co-sinical Parrallels, and that point shall cut in the Sinical Parrallels, the difference of Latitude, and the edge of the Index shall shew in the limb the Course, which is the fifth Rhomb, which was required.

Problem 6.

The difference of Latitude, and departure from the Meridian being given, to find the course and distance.

First, Find the difference of latitude in the Margent of Sinical Parallels; and also the departure in the Margent of the Co-sinical Parallels; and note where those Parallels meet each other, in that point put the Index, then on the edge of the Index shall be cut 45. the distance required; and one the limb, the edge of the Index will shew the fifth Rhomb which was required.

Problem 7.

To know how many leagues you must sail upon any point of the Compass to raise or depress a degree of latitude by the Sinical Quadrant.

To perform this, you must lay the Index upon the point of the Compass, and see where the Sinical Parallel of 20 leagues (which is one degree in the Equinoctial) doth interfect the edge of the Index, there will be shewn the quantity of leagues you must sail, to raise or depress the Pole upon any point of the Compass.

As for Example on the third Rhomb.

If you lay the Index on the third Rhomb, the Sinical Parallel no. 20, will shew 24 leagues, which you must sail on that point, to raise or depress one degree of latitude, and that point on the Index will shew in the Co-sinical Parallels, the departure from the Meridian to be 13 leagues 1 mile.

Problem 8.

Shewing the use of the Sinical Quadrant in working a Traverse at Sea.

The Sinical Quadrant, is a plain and ready instrument for this purpose, and is commonly imployed for the working of short Traverses at Sea; We give one Example of 24 hours run, in the manner as 'tis usually placed upon the Log board, and how it may be taken off and portracted by this Instrument.

Admit a Ship at Sea, and bound to the Northward, steers away her Course North East, but then meeting with a contrary and shuffling Wind she makes several Courses, as is hereunder expressed in this Table, after the form of a Log board.

H.	K.	C.	W.
2	8	N E	N W
4	12	E N E	N ½ E
6	13		
8	13		
10	13	E ½ N	N N E
12	14		
2	14		
4	8	E S E	N E
6	13		
8	14		
10	14	N N W ½ N	
12	14		

In this Table there are six Columns: The first distinguished with H. shews the time of hours at which these Courses and distances are thus set down upon the Log board, that is, at 2 o'th Clock, 4 o'th Clock, 6 o'th Clock, &c. the Log being constantly hove every two hours.

The second, third, and fourth Columns shews the Knots, half Knots and Fathoms that the Ship runs upon any course in the space of half a minute measured by an half minute Glass.

The fifth Column contains the Course steered by the Compass, the true

true walk that the Ship makes, being left to the discretion of the Calculator, to be allowed according to the mould of the Ship, and the Sail she bears; and also having respect to the Wind and Sea at the same time.

The sixth Column shews upon what point of the Compass the Wind is, and manifesting whether the Course be large or upon a Wind.

This much for the form of the Log board, and the manner of setting down the Courses and Distances thereon; now somewhat briefly, how to take off (as they call it) this account from the Log board, thereby to compute the Ships true Course and Distance by the Sinical Quadrant, or other Instrumental or Arithmetical Calculation: 'Tis usual for the Master, his Mates, and all others that are desirous to keep a Reckoning of the Ships way, every day at noon when the Ship is at Sea, to take an account of the several runs upon the Log board, of the 24 hours last past, taking notice of the Wind and other Accidents, allowing for every Knot and half Knot, so many miles and half miles run in one hour, and four times so many in a Watch, or four hours; and because 'tis usual to heave the Log but twice in a Watch, or every two hours, and the Course and distance set down accordingly; therefore the Knots and half Knots upon the Log board, for each Course must be added together, and the total double gives the number of miles upon each respective Course; as for instance, in this example in the Table, under the Letters of distinction (viz. H, K, H K, &c.) in the first Parallel, you will find 4 Knots N E. which being doubled, gives 8 miles the distance upon that Course. But now for the more orderly working the 24 hours run, 'tis convenient to frame a Table, after the form of this here annexed.

The Operation of these Traverses by the Sinical Quadrant.

1. The first Course is North East 8 miles, the wind large, therefore lay the Index upon the fourth Rhomb, or 45 degrees from the Meridian, you shall find the distance run 8 miles upon the Index, to intersect at 5 ½ in the Sinical Parallels, which is the Northing, and is to be placed in the North Column, and 6 cut 5 ½ in the Co-sinical Parallels, which is the Easting, to be placed in the East Column (and the reason why the difference of Latitude, and departure now found by

A Table of the Northing, Southing, Easting & Westing of these Courses found by the Sinical Quadrant.

Course.	Dist.	N.	S.	E.	W.
	mil.	mil.	mil.	mil.	mil.
N E	08	08		08	
E by N	19	08		18	
E ½ S	24	02	24		fere.
ESE ½ S	21		10	18	
NNW ½ W	19	15			08
Sum		24	24	66	08
		12	W.	08	
Diff. of Lat.	No.	12		58	E.

the Sinical Quadrant, is set under the North and East Columns, is because the Course is between the North and the East.

2. The second course is North & by East 19 miles upon a Wind, the Course steered is East North East, the Gore lying within 3 points of the Wind, and allowing one point for Lee-ward-way, the true Course is as before East and by North; Therefore place the Index to the seventh point, or 78° 45' from the Meridian, and by 19 miles the distance there will be cut 3 ½ miles in the Sinical Parallels, which is the Northing, and 18 miles in the Co-sinical, which is the Easting.

3. The third Course is, (allowing as before one point for Lee-ward-way) East ½ point Southerly, and the distance 24 miles; therefore lay the Index to 7 ½ points, or 84° 22', (or almost 8) and by 24 found on the Index, shall be cut 2 ½ in the Sinical Parallels, which is the Southing and 24 *feré* in the Co-sinical, which is the Easting of this Course and distance; and what hath been said of these three Courses, the same is to be understood of all the rest in the foregoing Table, giving the same allowance as before, the Ship being still by a Wind.

Having thus therefore, according to these last instances, found the Northing and Southing, Easting and Westing of these several Courses and distances, and placed them in their proper Columns; sum up the miles in these Columns, and orderly subscribe their total, as in this Example.

The sum of the North Column, is 24 miles; of the South Column, 12 ½; of the East, 66; and of the West, 8 miles.

Then compare the North and South Columns together, and also the East and West; and deduct the lesser from the greater, as in the

the foregoing Table; the Southing is to be subducted from the Northing, and the Westing from the Eastings; the Remainder Northerly 22 miles is the difference of Latitude; and the residue under the East Column 58 miles, is the departure to the Eastward of the Meridian.

And if the direct Course, and nearest distance from the place where the Ship began this Traverse, to that where she now is supposed to be, were required, 'tis readily computed by the Sinical Quadrant. And to perform this, find where 22 in the Sinical Parallels intersects the Co-sinical Parallels of 58, and bring the Index to that point, and by the Index in the limb shall be shown the Angle of the Course 79 deg. *Fere*, (or somewhat more then) 7 points from the Meridian, viz. East and by North almost a deg. Easterly, and the distance run, found on the Index, will be 59 miles.

And thus after the form of this Example, you may find the difference of Latitude, departure from the Meridian of any 24 hours Traverse, and likewise reduce it to one course and distance.

And what is here in particular applyed to the Sinical Quadrant, the same is to be understood of the other Instruments for the Operation of Nautical Problems, it being only a repetition of the first Case, by the Course and distance given, to find the difference of Latitude, and the departure, which found, is orderly to be placed in a Table, as in the foregoing Example.

Having spoken somewhat of the Log-board, and of the Use thereof, I think it not amiss here to speak something of the Log-line and Half-minute Glass.

An Advertisement concerning the Log-line, and half-minute Glass.

Seeing that the manner of keeping a Reckoning of the Ships way (by our *English* Navigators) is commonly by the Log-line and half-minute Glass, & there ought to be great care had to the truth of them; but it hath been an antient custom to measure seven fathom between knot and knot upon the Log-line; which way of measuring hath been grounded upon a meer conjecture, that 5 of our feet make a pace, and a thousand such paces make a mile, and that 60 such miles make a degree;

grees, so that a degree should contain 300000 of our feet, and one mile (or minute) 5000 feet; and because an half minute of time is the 120th part of an hour, the Log-line should answer to that proportion, and be the 120th part of a mile, which by this account is 41½ feet, between each knot on the Log-line.

But this erronious computation, hath been sufficiently refuted by Mr. *Oughtred*, Mr. *Norwood*, and others: Mr *Oughtred* in his *Circles of Proportion*, pag. 153. doth there propose 60 ½ Statute miles to answer to one degree upon the Earth, each containing 5280 feet; so that according to this computation there is 319680 English feet in one degree: And Mr. *Norwood* in his *Seamans Practice*, pag. 43. doth declare, *That* (by a worthy and commendable Experiment of his) *he found a degree of the Circumference of the Earth and Sea, to contain* 367200 *of our English feet*: But he further consenteth, *That because the Ships way is more, then doth really appear by the Log-line, and because it is more safe to have the Reckoning to be somewhat before the Ship, together with the evenness of the number, to allow but* 360000 *feet to one degree, and consequently* 6000 *English feet to one minute, or* 60*th part of a degree, (vulgarly called a mile) which number being divided by* 120, *giveth* 50 *feet between knot and knot on the Log-line*: *so that upon the ground, if a Ship runneth out one of those knots in half a minute, she runneth one mile (or the sixtieth part of a degree) in an hour, or one League and one mile in a watch, (or* 4 *hours.)*

But notwithstanding Mr. *Oughtreds* absolute assertion, and especially this Experiment of Mr. *Norwoods*, together with the consent and approbation of Mr. *Collins* and Mr. *Philippes* (*Accomplished Arithmaticians*) in their Books of the *Plain Scale new plained*, and *Advancement of Navigation*, have sufficiently detected this error; yet this truth hath not had that entertainment, as the excellency thereof hath deserved; because custom hath so long prevailed against reason.

Mr. *Norwood* in his forementioned Book, hath assigned some reasons why he supposeth this error hath been so long received and tollerated, I shall forbear to mention them, referring you to the Book it self. But I shall assign one reason more which I have observed, from the experience of our *English* Navigators, which I hope will in some measure help to prove the Truth of Mr. *Norwoods* Experiment, and that the Log-line (as commonly divided) may be proved to be too short for true measure; for it is observed, that if a half-minute Glass be made of its due length, and according to true time, that then their reckonings intollerably out-run the Ship, and they continually complain, that

those

those Glasses are too long: But if they have a Glass that is 5 seconds shorter then true time, they do reasonably well agree with the Log-line in their Reckonings, because one error doth counterpoise another, *viz.* short measure and short time; yet notwithstanding this concurrance and affinity there is between the Log-line and short half-minute Glass, it is apparent that they are both errors, and therefore to be rejected, for I suppose it would quickly appear, that if the Log-line were of its due length and measure, (*i.e.*) 50 foot between each knot, and the half-minute Glass of its due length, according to true time, there would doubtless be a greater harmony and concurrance of truth, and Navigation be of more certainty then it is.

So that now it doth plainly appear, by this above mentioned Observation, that the Log-line, as commonly divided, is too short, according to *Mr. Norwood's* Experiment, because the necessity of keeping a concurrance in the Reckoning, is by a Glass that is too short, 5 seconds for the true time of half a minute, or 20 seconds.

But here I shall give you an infallible Rule to prove whether a half-minute Glass be of true length or not, the way is generally approved to be very true, and what I have many times made experience of, and can attest upon my own knowledge. The Experiment I had from *Mr. Philippes*, in his *Advancement of Navigation*, and is thus to be performed.

An easie and exact way to measure a Half-minute Glass, or any small portion of time.

Take a Bullet of any weight whatsoever, and make fast a piece of thread or silk to it, being 38 ½ Inches in length, from the Center of the Bullet, unto the end of the thread where a noose must be made to hang it on a small Pin, which is to be fastned to any place where the Bullet may swing freely.

This Pendulum being thus prepared, hang his noose on the Pin, the thread being exactly 38 ½ inches between the Center of Gravity, and the Center of Motion, each of the swings of this Bullet (being either swift or slow) shall be a true second of time; so that 60 of these swings will be the true length of a minute, and 30 the true length of half a minute; so by this ingenuous Experiment, you may know which of all your half minutes is a true Glass; and if you have no Glass, you may measure any small portion of time by this Experiment, for half a second of time is discovered every time the Pendulum doth pass the

the Perpendicular, that is supposed to fall from the Pin whereon the Pendulum doth hang.

But if it should be objected, that at Sea, when the Ship may be thrown too and again by the violence thereof, that then the Vibrations of the Pendulum may by that means be obstructed, and so the swings to be uncertain.

A remedy there is proved against this, by making the thread 2 inches shorter, and there to make a small knot, which knot you are to hold between your finger and thumb, and then with a motion of your hand, to cause the Bullet always to ascend to an Angle of 60 degrees (from the Perpendicular) and so shall each swing be equivalent to those before; so that if a Ship be tossed with the violence of the Sea, yet a man may make shift to officiate in this Experiment, and to measure a true half-minute of time without the help of a Glass.

The Use of Gunters Scale.

As for the description and making of this Instrument, I shall silently pass it over, being sufficiently explained and treated of by Mr. *Gunter*, Mr. *Wingate*, and others, and commonly known to most Artists, we have in the former part of this Book, shown the joynt use of the lines of Numbers, Sines, Tangents, and versed Sines inscribed on this Scale, in the several Cases of right lin'd and Spherical Triangles, and in their application to sailing, both according to the Plain, and also the true Chart.

That which we shall further add, is the use of the line of Numbers, in working some necessary Proportions in Arithmatick and Geometry.

Numeration on the Line of Numbers.

A whole Number being given, to find the point in the line of Numbers, that doth represent the same.

The Rule.

First, Among the figured divisions, look for the first figure of your Number; then for your second figure, Count so many tenths from the long

long divisions, on towards the end of the Rule, as the minutes in the second figure amount to; then for the third figure, count from the last tenth so many Contesmes as that figure hath units; and so likewise for the fourth Figure, count from the last Contesm so many millions (or thousands) as the same fourth Figure contains unites, this done, that shall be the point where the number propounded is represented on the line of Numbers.

Example, 1.

The number given being 12, I demand the point of the line of Numbers that doth represent the same?

Therefore according to the Rule, 1 being the first Figure of this Number, I take the division at the Figure one (in the middle of the line) for the first Figure; then the second Figure being 2, I count two tenths from that one, and that is the point representing 12, where commonly there is a small brass Center, because it's often in use.

Example, 2.

Suppose the point representing 144 were required to be found upon the line of Numbers.

First, For the first figure in the number being one, I take (as before) the middle 1; then for the second figure, which is 4, I count 4 tenths onwards, and from that tenth, I count 4 Centesms, or hundred parts further, and that is the point representing 144.

Secondly, To find the point representing 1728, first (as before) for a thousand, I take the 1 in the middle of the line; secondly, for the second figure, being 7, I reckon 7 tenths onwards, and that is 700; thirdly, for the third figure, being 2, I reckon 2 Centesms from the 7 tenths, which representeth 20; and then lastly, for 8 you may reasonably estimate 8 millions, or thousand parts, from the last Centesm, (if the Centesms are not subdivided) and that point last found, will be the point representing the number 1728.

To find a Fraction, or broken Number, on the Line of Numbers.

The Fractions that are to be found on the line of Numbers, ought alwayes to be decimal Fractions, $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, (or 1, 01, and 001)

either inches, feet, yards, pearches, or the like; also in weight or time, or any other denomination, all other Fractions must be reduced into decimals; and being thus considered, they are expressed as whole Numbers upon the Line.

Note, If you call 1 at the beginning of the line, one tenth of any integer, then two following must be two tenths; 3, three tenths, &c. and the 1 in the middle, one Integer; 2, two Integers, &c. and 10 at the end must be ten Integers.

But if 1 at the beginning be one Integer, then 1 in the middle must be ten Integers; and 10 at the further end 100 Integers; and all the intermediate figures, 20, 30, 40, 50, 60, 70, 80, 90, so many Integers; and every longest division between, as 21, 22, 23, 24, 25, 26, &c. single Integers; and the shortest of those divisions, tenths of those Integers; and so in proportion infinitely, as $\frac{1}{10}$, 1, 10. 1, 10, 100. 10, 100, 1000. 100, 1000, 10000, &c.

Problem 1.

Two Numbers being given, to find a third Geometrically proportional unto them; and to a third a fourth, and to a fourth a fifth, &c.

Example.

Let the two numbers given be 2 and 4, unto which it is required to find a third proportional, &c. Therefore for the performance hereof by the Line of numbers, extend the Compasses from one of the Numbers given to the other; this done, if you apply the same extent either upwards or downwards, from either of the numbers propounded, the moveable point of the Compasses will fall upon the third proportional required; and so the same extent being applyed the same way, from the third, the moveable point of the Compasses will fall upon the fourth proportional, and from the fourth to a fifth, &c. and so to more, as you please; for if you extend the Compasses from 2 to 4, and turn the Compasses upwards, with one point resting on 4, the moveable point will fall on 8, the third proportional, and from 8 to 16, and from 16 to 32, and from 32 to 64, and so forward.

Problem

Probleme 2.

One number being given, to be multiplyed by another number given, to find the product.

To reſolve this Queſtion Arithmetically, whether by natural or artificial numbers, the proportion is, as 1 is to the Multiplicand, ſo is the Multiplicator to the Product.

Example.

Let the Multiplicand 8 be multiplied by 5 the Multipſicator, extend the Compaſſes on the line of Numbers, from 1 to the Multiplicand; the ſame extent being applyed the ſame way from the Multiplicator, will cauſe the moveable point to fall on the Product; for if you extend the Compaſſes from 1 to 8, the ſame extent the ſame way will reach from 5 to 40: and ſo if you would now multiply any number by 8, as the Compaſſes now ſtands, it is but placing one foot in any number given, and the moveable point will fall on the Product, as if you place one foot in 9, the other will fall in 72, and ſo from 8, it will fall in 64, and from 7 to 56, and from 6 to 48, ſo that the Table of Multiplication may by this be eaſily made; the extent of the Compaſſes may be taken from 10, at the further end of the line, which you may call 1.

Probleme 3.

One number being given, to be divided by another number, to find the Quotient.

For the reſolution of this Probleme, the proportion is thus, as the diviſor is to 1, ſo is the Dividend to the Quotient.

Example.

Let 40 be the Dividend, and let the Diviſor be 8; therefore extend the Compaſſes on the line of Numbers from the Diviſor to 1; this done, the ſame extent the ſame way, ſhall reach from the Dividend to the Quotient, which is 5.

Another Example.

Let 750 be a number given, to be divided by 25; therefore extend the Compaſſes downwards from 25 to 1, then applying that extent the ſame way from 750, the moveable point will fall upon 30, which is the Quotient required.

Now to know of how many figures any Quotient ought to conſiſt.

It will be neceſſary to obſerve how many times the Diviſor may be written under the Dividend, according to the Rules of Diviſion, for of ſo many figures ſhall the Quotient be compoſed of.

For Example, 12231 being given to be divided by 27, which ſaid number may be written according to the Rules of Diviſon, three times under the Dividend; therefore the Quotient ſhall conſiſt of three figures, and ſo of any other.

Probleme 4.

To three numbers given, to find a fourth in a direct proportion, as in the Rule of Three direct.

To reſolve this Probleme, the proportion is thus; As the firſt Number given is to the ſecond, ſo is the third number to the fourth.

To perform this on the Line of Numbers, you muſt extend the Compaſſes from the firſt number or tearm given, unto the ſecond; which done, that extent being applyed the ſame way from the third tearm, will cauſe the moveable point to fall on the fourth tearm required.

Example.

If the circumference of a Circle, whoſe diameter is 7 inches, be 22 inches; what circumference will a Circle have, whoſe diameter is 14 inches?

Therefore extend the Compaſſes in the Line of Numbers from 7, in the firſt part thereof, unto 14 in the ſecond; this done, the ſame extent being applyed the ſame way from 22, will make the moveable point to fall upon 44 inches the circumference required.

Example, 2.

Let the circumference of a Circle be 22 inches, and the diameter thereof 7 inches, how much ſhall the diameter of a Circle be, whoſe cuircmference is 44 inches?

Extend

Extend the Compaſſes downwards, from 22 in the ſecond part of the line, to 7 in the firſt; which done, that extent being applyed the ſame way from 44, will reach to 14 the diameter ſought.

Probleme 5.

To three numbers given, to find a fourth in an inverſed proportion, (or in the backer Rule of Three.)

To reſolve this Probleme, the proportion is, as the third number is to the ſecond, ſo is the firſt to the fourth.

Example.

If 60 men make a Trench in 45 hours, in what time will 40 men make ſuch another?

To perform this by the line of Numbers, extend the Compaſſes from the firſt of the numbers given to the ſecond, having both the ſame denomination; this done, if this extent be applyed backward from the third number, the moveable point will fall upon the fourth number required; ſo that if you extend the Compaſſes from 60 to 40 (thoſe tearms being of the ſame denomination) *viz.* of men; this done, the extent being applyed backward from 45, will reach to 67,5, the fourth number you look for. I conclude therefore, that 40 men will perform as much in 67 hours and an half, as 60 men will do in 45 hours.

Probleme 6.

To three numbers given, to find a fourth in a doubled or duplicate proportion.

The uſe of this Probleme appears chiefly in proportions of lines to ſuperfecies, or of ſuperfecies to lines; Now if the denomination of the firſt and ſecond tearms be of lines, then extend the Compaſſes from the firſt tearm to the ſecond, (of the ſame denomination) this done, that extent being applyed twice, the ſame way from the third tearm, the moveable point will ſtay upon the fourth tearm required.

Example, 1.

If the content of a Circle, whoſe Diameter is 14 Inches, be 154 inches, what will the content of a Circle be, whoſe diameter is 28 inches?

Here

Here 14 and 28 having the same denomination, *viz.* of lines, I extend the Compasses from 14 to 28; then applying that extent the same way from 154 twice, the moveable point will fall on 615 the fourth proportional sought, that is first from 154 to 308, and from 308 to 616.

But if the two first tearms have the denomination of Area's, or contents, and the quesitum be a line, then extend the Compasses upon the line of Numbers, until half the distance between the first and second tearm of the same denomination; so the same extent will reach from the third tearm given, to the fourth required.

Example, 2.

If the diameter of a Circle, whose Area is 154 inches, be 14 inches, what diameter will a Circle have, whose Area is 616 inches?

Divide the distance betwixt 154 and 616 into two equal parts, then set one foot in 14, the other shall reach to 28 the diameter required.

Probleme 7.

To three numbers given, to find a fourth in a treplicate proportion.

The use of this Probleme, consisteth in the proportion of lines solids & contra.

If therefore the first and second tearms have the denomination of lines, (as the diameters of Circles, or the sides of solid bodies) extend the Compasses upon the line of Numbers, from the first tearm to the second; this done, and that extent applyed three times, the same way from the other tearm will cause the moveable point at last to fall upon the fourth tearm required.

Example, 1.

If an Iron Bullet, whose diameter is 4 inches, weigheth 9 pounds, what is the weight of another Iron Bullet whose diameter is eight inches?

Therefore extend the Compasses on the line of Numbers from 4 to 8; which done, and that extent applyed the same way three times, from 9, the moveable point will first fall upon 18, then from 18 to 36; and lastly, from 36 to 72, the weight required.

But if two given tearms be weight or contents of sollids, and the diameter

diameter or side of a square or a line is sought, then divide the space between the two given tearms of the same denomination into three parts, and that distance shall reach from the third to the fourth proportional.

Example, 2.

If an Iron Bullet that weigheth 9 pound be 4 inches diameter, what diameter shall that shot of Iron be, whose weight is 72?

Divide the space between 9 and 72 in 3 parts, and that third part shall reach from 4 to 8 the diameter required.

Example, 3.

Also if a Cube whose side is 6 inches, contain 216 inches, how many inches shall a Cube contain whose side is 12 inches?

To perform this proposition, extend the Compasses upon the line of Numbers from 6 to 12; that extent measured upon the Line of Numbers three times, shall at last fall on 1728 in the second part of the line of Numbers.

Probleme 8.

To find the square Root of any number under 1000000.

The square root of any number, is alwayes the mean proportional betwixt 1, and the number propounded; but yet with this general caution, *viz.* if the figures of the numbers be even, that is, 2, 4, 6, 8, 10, *&c.* then you must look for the unite, or one, at the beginning of the line of numbers, and the number given in the second part, and the Root in the first part, or rather reckon 10 at the end to be the unite, and then both Root and Square will fall backwards towards the middle, in the second part of the line; but if they be odd, then the middle one will be most convenient to be counted the unite, and both Root and Square will be found from thence forwards towards 10; so that according to this Rule, the square of 9 will be found to be 3; the square of 64, will be 8; the square of 144, will be 12; the square of 1444 to be 38; the square of 57600 to be 240; and the square of 972196, will be found to be 986. And to know how many figures any Root ought to consist of, put a prick under the first figure, the third, the fifth, and the seventh, *&c.* beginning from the right hand, and as many pricks as are noted, so many figures there must be in the Root.

Probleme

Probleme 9.

To find the cubique Root of a Number under 1000000000.

The Cubique Root is alwayes the first of two mean proportionals, between 1 and the number given, and therefore will be found, by dividing the space between them into 3 equal parts. And to find how many figures will be in this Root, you must prick under the first figure, the fourth, seventh, tenth, beginning at the right hand; and so many pricks as you find, so many figures must be in the Root, which Root may be easily found with these cautions.

1. If the last prick fall on the last figure towards the left hand, then the unite is best placed at 1 in the middle of the line, and then the Cube and Root will both fall forward toward 10 at the end of the line.

2. If the last prick fall on the last figure but one towards the left hand, you may place the unite at 1 in the beginning of the line, then will the Cube and Root both fall in the second part of the line, between 1 in the middle, and 10 at the end of the said line.

3. If the last prick fall on the last figure but two, then alwayes place the unite at 1 to the end of the line, and then the Cube and Root will both fall backward, and be found in the second part of the line of Numbers.

These notes being observed, the Cube Root of 1728, will be found to be 12; and the Cube Root of 17576, will be 26; and the Cube Root of 438976, will be found 76; and the Cube Root of 8120601, will be 201; the Cube Root of 11390625, will be 225; and lastly, of 513922402, will be found to be 801.

We might have added many more Problems in the Rule of Proportion, but these are more common and most usual, for the rest, I refer you to others that particularly write hereof.

The Use of the Sector.

I shall not here give a description of the Sector, much less shew the making thereof, or speak any thing of the alteration therein by Mr. *Foster* and others, it having been largly handled by abler Pens; my intention here, being briefly to mention some Propositions performed by

by the Line of Lines, and the Line of Sines and Tangents on the Sector, which may be useful in Navigation.

Of the Line of Lines.

First proposition.

To divide a line given, in any number of equal parts required.

Take the length of the Line given between your Compasses, and open the Sector according to the length of the said line, in the points of those parts whereunto the line should be divided; then keep the Sector at the same Angle, the parallel distance between the points of 1 and 1, shall divide the line given into the parts required.

Let A B be a line given to be divided into 5 parts: First, I take this line A B, and to it open the Sector upon 5 and 5, the parallel between 1 and 1, doth give me the distance A C, which doth divide the line A B in the parts required.

Second proposition.

Three numbers being given, to find a fourth in a direct proportion.

For the solution of this Question, reckon the first and third numbers, which are of the same denomination, on both sides of the Line of Lines from the Center, and mark the tearms, to which either of them extend, then take out a line resembling the second number, and to it, open the Sector to the tearms of the first number; for so keeping the Sector at this Angle, the parallel distance between the tearms of the third lateral number, being measured in the same Scale from whence his parallel was taken, shall give the fourth proportional number sought.

Example.

If a question were proposed in this manner, If 10 yards cost 8 pound, how many yards may be bought for 12 pounds?

The numbers by themselves will stand in this order, if 8: 10: 12:

and the fourth proportional will be found to be 15 yards; for as 8 is to 10, so is 12 to 15.

Of the Lines of Chords and Sines.

Third proposition.

The Radius of a Circle being given, to find the Chord of any Arch thereof.

To perform this, open the Sector at the points of 60 and 60 in the line of Chords, to the extent of the given Radius, and the parallel Chord taken in his proper points, will be the Chord sought. As suppose the Chord of 23° were required, then the parallel taken between the points of 23 and 23, in the line of Chords, shall be the Chord required conformable to the Radius.

If your Sector have not a line of Chords, the line of Sines will supply the want thereof, because the right Sine of an Arch is half the Chord of twice that Arch; and consequently, the right Sines being doubled, become Chords. And therefore to perform the last Probleme by the line of Sines, do thus, Open the Sector in the points of 30 and 30, on the lines of Sines, to the length of the Radius given, and the parallel taken between the Sines of half the Arch proposed, shall be the Chord sought, as before.

Fourth proposition.

The Chord of an Arch given, to find the Radius or Semi-diameter thereof.

This is only the converse of the last Proposition, and may as readily be performed; for if you make the Chord given, a parallel in his proper points on the line of Chords, the parallel between 60 and 60 shall be the Radius or Semi-diameter required. The like may be understood in the using the line of Sines, half the Sine being taken instead of the Chord, and the Radius is found in the points of 30 and 30 on that line.

Fifth proposition.

The Radius being known, to find the right Sine of any Arch or Angle.

If

If the Radius of the Circle given, be equal to the lateral Radius, that is, to the whole line of Sines on the Sector, there needs no farther work, but to take the other fines on the fide of the Sector; But if the Radius be either greater or leſſer, then let it be made a parallel Radius, by applying it in the line of Sines between 90 and 90; ſo the Parallel taken from the like lateral Sines, ſhall be the fine required.

Sixth propoſition.

The right Sine of an Arch being given, to find the Radius.

Turn the Sine given into a Parallel Sine, and his Parallel Radius ſhall be the Radius required.

Some Propoſitions of plain Sailing, performed by the Sector.

Seventh propoſition.

A Ship ſails North-Weſt by Weſt 54 Leagues, I demand the difference of Latitude, and the departure from the Meridian?

To perform this, take the diſtance 54 Leagues upon the Line of Lines, or equal parts, and fit it in the points of Radius, or 90 and 90 in the line of Sines, and the parallel thereto, taken between the fines Complement of the Courſe, *viz.* 33° 45′, and meaſured on the line of equal parts, will give 30 leagues *fere* the difference of Latitude, and the Sector thus ſtanding, the parallel taken between the fines of the Courſe, *viz.* 56° 15′, and meaſured on the line of equal parts, will be found to be 44 Leagues $\frac{2}{12}$, the departure from the Meridian.

Eighth propoſition.

A Ship ſail South East by East, until her difference of Latitude be 30 *Leagues, I demand the diſtance run and departure?*

To perform this, take 30 Leagues from the line of equal parts, and make it a Paralſel between the Sines Complement of the Courſe, *viz.* 33° 45′; and the parallel taken between 90 and 90 in the line of fines, and meaſured on the Line of Lines, or equal parts, will give the diſtance 54 $\frac{1}{12}$ Leagues; and as the Sector ſtands, the parallel taken be-

tween the fines of the Courſe, *viz.* 56° 15′, and meaſured as before, gives the departure 45 leagues, which was demanded.

Ninth propoſition.

A Ship ſails between the South and the Weſt 54 Leagues, until the difference of Latitude be 30 *Leagues, I demand the courſe and departure?*

To reſolve this Propoſition, take the diſtance 54 Leagues, from the line of equal parts, and place it between the points of 90 in the line of Sines; then take 30 Leagues, the difference of Latitude from the ſame Scale, and with this extent carry the Compaſſes along in the line of Sines, until they become a parallel in the ſaid line; the points where the Compaſſes ſtay, ſhews the Sine Complement of the Courſe 33° 40′; and the Sector remaining at the ſame Angle, take the parallel between the fines of 56° 20′, which meaſured on the lines of equal parts, gives 45; ſo that the Ship hath ſailed South Weſt by Weſt more Weſterly, and her departure 45 Leagues, which was required.

Tenth propoſition.

A Ship ſails North Weſt by North, until her departure be 30 *Leagues, I demand the diſtance and difference of Latitude?*

To anſwer this by the Sector, take 30 from the line of equal parts, and fit it in the points of 33° 45′, the fines of the Courſe, and the parallel taken between 90 and 90 in the line of Sines, ſhall be the diſtance run 54 Leagues $\frac{2}{10}$; and the Sector thus ſtanding, take the parallel between 56° 15′, and that will be found by the equal parts to be 45 Leagues, the difference of Latitude required.

Eleventh propoſition.

A Ship ſails between the North and the Eaſt 54 Leagues $\frac{2}{10}$, *until her departure be* 30 *Leagues, I demand the courſe and difference of Latitude?*

To work this Propoſition by the Sector, take 54 $\frac{2}{10}$ on the Line of Lines, then meaſure 30 Leagues upon the proper Scale, and try whether it will fit parallel-wiſe in the Sines, the points where the Compaſſes ſtay, is the fine of the Courſe, *viz.* 33° 45′; and the Sector being

being ſtill at the ſame Angle, take the parallel between the ſines Complement of the Courſe, *viz.* 56° 15′, and that being meaſured, will be found to be 45; ſo that the Courſe is North-Eaſt by North, and the difference of Latitude 45 Leagues.

Twelfth propoſition.

A Ship ſails between the South and the Weſt, until her difference of Latitude be 30 Leagues, and her departure 45 Leagues; I demand the courſe and diſtance?

To perform this, take the difference of Latitude 30 Leagues, and fit that extent in the points of 45 and 45, in the leſſer Tangent Line, (in which the Tangent of 45° is not far from the Center of the Sector) and then take 45 from the line of equal parts, and carrying the points of your Compaſſes parallel-wiſe, they will ſtay in the Tangents of 56° 15′, which gives the Courſe South-Weſt by South; and if your Sector hath a line of Secants, keep the ſame Radius to which you fitted your Tangent 45°, and the parallel taken in the Secant of 56° 15′, the Secant of the Courſe, and meaſured on the equal parts, gives 54 ½ Leagues the diſtance run: But if your Sector hath but one line of Tangents, whereon the Tangent of 45° is placed at the end of the Sector, then take 45 Leagues the departure, and fit it in the points 45 and 45 on this Tangent Line; and then take 30 Leagues the difference of Latitude, and running your Compaſſes parallel in the ſaid Tangent Line, the points will ſtay in the Tagents of 33° 45′ the Complement of the Courſe, which gives the Courſe to be 56° 15′ from the Meridian, or South Weſt by Weſt; then for the diſtance, fit the difference of Latitude 30 Leagues in the Sine Complement of the Courſe 33° 45′, and the parallel between 90 and 90 in the line of ſines, gives the diſtance to be 54 Leagues ½.

Note, If you are deſirous to work a Traverſe on the Sector, it is only the reiteration of the ſeventh Propoſition; ſetting down the reſults of Latitude and departure, or the Northing or Southing, and Eaſting or Weſting of the ſeveral courſes and diſtances in a Table for that purpoſe, (as is ſhown in the Sinical Quadrant) and then the Operation is very ready and facile by this Inſtrument, and needs no Example for Illuſtration.

The

The description of the plat in plano.

These Plats are commonly drawn upon Vellom, and pasted upon Boards; in the middle of the Plat is a Center, upon which there is an occult Center described, which is commonly divided into 16 or 32 parts or points; so by every one of the points (from the Center) are drawn several lines quite through the Plat, representing the Rhombs or Points of the Compass, necessary for the use thereof.

Then is the fashion and form of the Land portraied upon it, and curiously set off with lively Colours; and also a Scale of Leagues to measure the distances of places.

There is also a Meridian Line equally divided upon the Plat, which discovereth the Latitude of any place; the several Uses follow.

The Use of the Plat.

1. To find the Latitude of any Place upon the Plat.

Take your Compasses, and set one foot in the place required, and extend the other foot to the neareſt East and West line, and note where that East and West line doth cut the Meridian line, (that is divided into degrees) then set one foot in the said East and West line, where it intersects the Meridian line, and the other foot will reach upon the said line, to the Latitude of the place required.

2. To find the distance of one place from another.

If the distance required be less then the length of the Scale, then take your Compasses, and set one foot in one of the places, and the other foot in the other place, then with that extent between your Compasses, apply to your Scale of Leagues, and then you will find the measure of the distances of the two places.

But if the distances between the two places be greater then the length of the Scale, then first extend your Compasses upon the Scale

to

to the whole length thereof, and with that extent, set one foot in one of the places required, then direct the other foot towards the other place in the right line: and if the distance be very great, you must turn the distance over and over, until you come to the other place required; and if it falls out, that the last extent doth fall over the second place, you must then, from the last place where the Compass stayed, draw in the other point, until it touch in the place required, and measure that upon the Scale of Leagues. As suppose you were an 100 Leagues, and if you turn the Compasses 2 or 3 times over, then is the distance so many 100 Leagues, and that small distance more; which being measured upon the Scale, it giveth the odd Leagues, and so consequently the distance required.

3. To find upon what Point of the Compass one place beareth from another.

If from the two places propounded, there be a Rhomb line that lieth directly from place to place, then is there no more trouble in it, but to look upon the small Compass upon the Plat, and see what Rhomb it is that they bear one from another.

But if in case a Rhomb Line doth not lie so direct from one place to another, then extend your Compasses from the first place in the nearest distance to the next Rhomb line, that you imagine in your judgment lyeth nearest a parallel from place to place, and upon that Rhomb Line run your Compasses along, until the other point (being at right Angles with it) doth reach the other place, and that Rhomb Line is the true point of bearing the one from the other.

4. To keep a Reckoning upon the Plate of the whole Voyage.

First, It is to be understood, that you are to keep a Reckoning of every dayes work, either by the Tables, or your Sinical Quadrant, (as you are before taught) or any other way necessary for such a purpose; and also to cast up all your Traverses for one or more dayes: and then after you have so done, and brought it to the nearest truth you can, either by observation or otherwise, then you are to set off your work upon your Plat, so that the Plat where your Ship is, may appear to

your

your eye for the satisfaction of your mind, and for the information of your judgment.

As suppose that you sail from the *Lizard* South Eastwards, then from that very time you begin to keep your Reckoning of your several Courses and distances by your dead Reckoning, until you have some convenient time to cast up all your work.

To find the difference of Latitude, and your departure from the Meridian of the *Lizard*. The difference of Latitude we will suppose to be 3°, and the departure to be 50 Leagues, which degrees you must substract from the Latitude of the *Lizard*, which we suppose to be 50° 00′ North; so that the Latitude that the Ship is now in, is 47° 00′, and 50 Leagues to the Eastwards.

Therefore to set the place of your Ship upon your Plat, you must use two pair of Plat Compasses, with one pair take the extent between the Latitude of 50° 00′, and 47° 00′; and set one point of your Compasses in the *Lizard*, and extend the other point towards the second place, but so, that your Compasses may stand parallel to a North and South Line, which may be easily found with the other pair of Compasses, by trying whether the Legs be equi-distant from the next North and South Line; this done, keep one foot of your Compasses in that point, and with the other pair, take the departure 50 Leagues from the Scale of Leagues, then interchange your Compasses, placing these last pair, in the point where the other pair stood, set this departure 50 Leagues to the Eastwards; and so, that your Compasses may stand parallel to an East and West Line, which you may try, as is said before; the second point thus found upon the Plat, is the place of the Ship, (according to your reckoning) which was required. Thus much for the Plat according to Plano.

To keep a Reckoning upon the Plat of the whole Voyage.

The

The Use of the True (commonly called Mercators) Chart.

I shall not here mention the projection of this Chart, it being largly handled by the first Inventer, Mr. *Edward Wright*, in his *Correction of Errors*, we shall only here shew very briefly, the ordinary and most necessary uses of this Chart.

1. To find the Latitude of any Place in these Charts.

This Operation upon these Charts, is in all respects like that which has already been delivered for the same purpose, in the Use of the Plat, or plain Sea Chart; for if you set one point of your Compasses in the place whose Latitude is required, and open them in the shortest distance to the next East and West line, observing where that Parallel intersects the graduated Meridian, and then place one point in that intersection, turning your Compasses upwards or downwards, according as the place lies, from the East and West line, and the moveable point shall shew upon the said Meridian the Latitude of the place required.

Example.

Suppose the Latitude of Ushant *were required by this Chart.*

If you take the nearest extent to an East and West Line, and place that distance from the intersection on the graduated Meridian, as is before directed, you will find the Latitude of *Ushant* to be 48° 30′ Northerly.

2. To find the Longitude of a Place, and consequently the difference of Longitude in degrees, between any two places scituate upon the Chart.

To find the Longitude of any place upon the Chart, set one point of your Compasses in the said place, and take the nearest distance to

the next North and South Line, and observe where this line intersects the Equinoctial, and keeping the same extent in your Compasses, place one point in the intersection, and turning the Compasses the same way, that the place whose Longitude is sought, lies from the North and South line, the moveable point resting in the Equinoctial, will shew the Longitude required.

Example.

Suppose the Longitude of the Barbadoes *were required.*

If you place one point of your Compasses in the Island of *Barbadoes* in the Chart, and take the shortest extent to the next North and South line, placing the same at the intersection in the Equinoctial as is directed, you will find the Longitude of the *Barbadoes* to be in the ordinary Charts 317° 30′ from *Teneriff*; but the Longitude of places being various, according to the places from whence it is begun, some reckoning it from *Flores* and *Corvus*, some from *Tenerif*, &c. The chief business will be to find the difference of Longitude between any two places, which is thus to be performed.

If the degrees of Longitude found for two several places, be each of them less then 180° 00′, then substract the lesser from the greater, the remainder is the difference of Longitude required.

As for Example.

Suppose the two places to be the *Lizard* in the Longitude of 10° 40′, and *Thoma* Island, under the Equinoctial, in the Longitude 27° 30′, the difference in Longitude is 16° 50′.

But if the Longitude of one of the places exceeds 180° 00′, substract the same from 360° 00′, and to the remainder add the Longitude of the other place, the sum is the difference of Longitude required. For instance, Suppose you find the Longitude of the *Lizard* by the Chart to be 10° 40′, and the Longitude of the *Barbadoes* 117° 30′, the difference of Longitude will be 53° 10′.

3. To know how one place beareth from another upon the Chart.

For the performance of this Probleme, lay the edge of a long Ruler from one place to the other, and with a pair of Compasses, try to

which

which of the Rhomb lines the edge of the Ruler is the neareſt parallel, which being found, that ſheweth the point of the Compaſs the two places bear one from another.

Example.

Suppoſe the bearing of the *Barbadoes* from the *Lizard* were required, Therefore lay the edge of a Ruler upon both places, and you will find that the South Weſt ½ point Weſterly is the neareſt parallel thereto, which is the bearing of the *Barbadoes* from the *Lizard*, and the oppoſite point North Eaſt ½ Eaſt the bearing of the *Lizard* from the *Barbadoes*.

4. To find the diſtance of two places upon *Mercators* Chart.

If both places are in one and the ſame Latitude, take with your Compaſſes the length of a degree of the Meridian at that Latitude, (taking half the degree above, and half beneath that Latitude) for ſo oft as you ſhall find that length between the two places, ſo many ſcore Leagues are there betwixt them; but if the diſtance be great, and for expedition, you may take 5 times the length of that degree, and counting it for an 100 Leagues, proceed as before.

Example.

Suppoſe the diſtance were required between the point of *Uſhant* in *France*, and *Trinity Bay* in *New-Found-Land*.

The diſtance taken as before, between the Latitude of 37ᵃ, you will find it to be 550 Leagues.

But if two places have not the ſame Latitude, the Equinoctial not coming between them, ſubſtract the leſſer Latitude out of the greater; but if the Equinoctial cometh between them, add both Latitudes together, ſo have you the difference of Latitude between both places.

Now if both places have the ſame Longitude, ſo many degrees as there is in the difference of Latitude, ſo many ſcore Leagues is the diſtance.

But if the places differ both in latitude and longitude, then look how many degrees the difference of Latitude contains, ſo many degrees of the Equinoctial take between your Compaſſes; then lay a long Ruler to both places, whoſe diſtance you ſeek, then obſerve

where the Ruler croſſes the Equinoctial, or ſome other East or Weſt line or parallel of Latitude; and leading one foot in the Equinoctial, or other parallel, move forwards the other alſo parallel-wiſe, keeping alwayes that diſtance, till it croſs the Rhomb of thoſe two places in ſuch ſort, that one foot reſting by the edge of the Ruler, the other carried about, may but only touch the Equinoctial, or other parallel cut by the edge of the Ruler; then having taken with your Compaſſes the Segment, or part of that Rhomb between the croſſing and the Equinoctial or parallel, ſet both feet in the Equinoctial; and ſee how many degrees are contained betwixt them, ſo many ſcore leagues is the diſtance of thoſe two places.

Or if that Segment of the ſaid Rhomb be greater then can well be taken with the Compaſſes, take the length of 5 degrees of the Equinoctial between the feet of your Compaſſes, and look how oft you can find that length in that Segment of the Rhomb aforeſaid, for ſo many hundred leagues is the diſtance of thoſe two places.

Example.

If the diſtance from the *Lizard* to the *Barbadoes* were required, the difference of latitude between thoſe places, is $36^{o}\ 48^{'}$; Therefore take $36^{o}\ 48^{'}$ from the Equinoctial, and laying a Ruler over both places, of a ſufficient length, it will croſs ſome parallel of latitude about 9 degrees; then keeping this diſtance of degrees in your Compaſſes, apply one point to the edge of the Ruler, ſo that the other point may but juſt touch the parallel croſſed by the Ruler; the Segment of the Rhomb, between the point where the Compaſſes ſtayes, and the interſection by the Ruler, and parallel of latitude, meaſured by the degrees of the Equinoctial, gives the diſtance 1141 leagues which was required.

There is nothing elſe that will be of any difficulty in the common uſe of this Chart, if theſe brief hints be underſtood.

The Description and Use of the Globes.

Of Globes, they are of two sorts, one is Terrestrial, and the other Celestial.

The Terrestrial hath on the superficies of the body, portraied and described the whole form and fashion of the Earth and Sea, with all the Circles of the Sphear, of Colors, Equinoctial Tropicks, &c.

The Celestial Globe hath on its surface, the Constellations of all the known Stars in the Heavens, placed in their true Latitudes and Longitudes, right Ascentions and Declinations, drawn into several Images and Figures, according to the feigned fictions of the Antients, with all the Circles of the Sphear, as in the Terrestrial Globe, which are treated of in the beginning of this Book.

The Material Globes are composed of these parts.

First, *The Body or Globe it self.*
Secondly, *The Brasen Meridian.*
Thirdly, *The Quadrant of Altitude.*
Fourthly, *The Hour-Circle and Index.*
Fifthly, *The Wooden Frame in which it is put.*

The Globe it self, with the Concerns and Apurtenances therennto belonging, is for the lively representation of the natural situation and position of the Earth and Heavens, and serveth for the demonstrating of any Problem incidant in the Sphear, and on the Earth, either in Astronomy, Geography, or Navigation.

1. The *Brasen Meridian* is divided into 4 parts or Quadrants, each being divided into 90 degrees; within this Meridian, the whole Body of the Globe turneth upon the Axis that cometh forth from the Body, being two strong brass Wiers.

2. The *Hour-Circle* is a flat Ring of Brass fastned upon the North part of the Meridian, and is divided into the 24 hours of a natural day; and each of these hours is subdivided into halves and quarters.

3. The *Quadrant of Altitude*, is a long and thin slip of Brass divided into 90 degrees, and is to move up and down upon the surface of the Globe to any position required; and when placed in the Zenith, the edge thereof representeth an Azimuth, and the divisions sheweth the Almicanters or Circles of Altitude.

4. The

4. The *Horizon* is a flat and round frame of Wood, in which the Brasen Meridian, and consequently the whole Globe doth move, being divided into a Kalender shewing the day of the Month, the place of the Sun, the Rhombs, &c.

Proposition 1.

How to set the Globe to the Latitude of any place.

Suppose you were to set the Globe to the Latitude of 52 degrees, the Globe being in the Frame, move the Meridian either higher or lower, until 52 doth cut the very edge of the Horizon, (the superfecies of the Brazen Meridian being toward you) then the Glob being turned North and South, by the help of a Magnetical Needle, it doth then represent the natural position of the Heavens and Earth. The Globe being in this position, it may answer these proportions following in that Latitude.

Proposition 2.

To find the Latitude of any place upon the Globe.

First, Find the place required upon the Globe, then turn the Globe about, until the places, whose Latitude is required, be just under the Brazen Meridian, then note what degree stands against it on the Meridian, that is the Latitude of the place which was required.

Example.

Let it be required to find the Latitude of *Rome*; turn the body of the Globe about, till *Rome* be just under the Brass Meridian, and you will see 42 to lie against it, which is the Latitude of *Rome*.

Proposition 3.

To find the Longitude of any place upon the Globe.

Turn the body of the Globe about, till the place, whose Longitude you require, comes under the Meridian; then observe what degrees of the Equinoctial are cut by the Brass Meridian, and the number of those degrees is the Longitude of the place you seek for.

Example.

Example.

Let it be required to find the Longitude of *Rome*, as before, therefore bring *Rome* under the Meridian; which being done, the Meridian will cut the Equinoctial in 36° 30′ the Longitude required.

Proposition 4.

To find the distance of any two places on the Globe.

To perform this, lay the Quadrant of Altitude upon both the places required, and note how many degrees there is contained between them; which being found, multiply by 60, and the product will give you the distance between the said places.

Example.

Let it be required to find the distance between *London* and *Rome*; Therefore lay the Quadrant of Altitude from one place to the other, and you will find 15 degrees to be intercepted between the aforesaid places, which being multiplyed by 60, giveth 900 English miles the distance between *London* and *Rome*.

Proposition 5.

To find the bearing of places one from another.

First, Set the Globe to the Latitude of one of the places, and bring the same place under the Brass Meridian, and extend the Quadrant of Altitude to the other place, and the end of the Quadrant shall point on the Horizon, the Rhomb or Point of the Compass that one place beareth from another.

Example.

Let it be required to know the bearing of *Rome* from *London*; Therefore bring *London* under the Brass Meridian, and there fit the Quadrant of Altitude, and lay the edge thereof upon *Rome*, and the end of the Quadrant of Altitude will point you to the South East and by East point of the Compass with the bearing of *Rome* from *London*.

Proposition 6.

The day of the month being given, to find what sign and degree the Sun is in.

First, Find the day of the Month in the Kalendar on the Horizon, and right against it, you shall find the sign and degree in which the Sun is.

Example.

Let it be required to find the Suns place on the fifth of *May*; You must find the fifth of *May* in the Kalendar, and right against it, you will find 25 degrees in *Taurus*, which is the Suns place that day.

Proposition 7.

How to place the Index of the Hour-Circle for every day in the Year.

The Globe being set to your Latitude, and the place of the Sun found, (as in the last Propositition) you must find that degree on the Ecliptick Line of the Globe, and bring that degree to the Brass Meridian; then staying the Globe there, turn about the Index of the Hour-Circle, till it points just upon the upper line of 12 in the Circle, which being done, the Hour-Circle is rectified for any time that day you use it upon.

Proposition 8.

To find the time of the Suns rising and setting.

The Hour-Circle being rectified, and the Globe set to the Latitude, then turn the Globe about till the degree, in which the Sun is, touch the East side of the Horizon; and then casting your eye upon the Hour-Circle, the Index thereof will shew you the time of the Suns rising; and the Globe being turned about, till the degree of the Sun touch the West side of the Horizon, then the Index will shew you the time of the Suns setting.

Example, 1.

Let it be required, to find the Suns rising and setting the fifth day of *May*, the Sun being then in 25 degrees in *Taurus*; First, Find the 25th degree of *Taurus* in the Ecliptick Line, which being turned to the East

East part of the Horizon, and you will find the Index point to 10 minutes after 4 of the Clock; the same point being turned to the West part of the Horizon, you will find the hour Index to point to half an hour past 7, the time of Sun setting.

By having the time of the Suns rising and setting, you may find the length of the day and night: for the time of the Suns rising being doubled, gives the length of the day.

Example 2.

This fifth of *May*, the Sun riseth at 4 of the Clock and 10 minutes past; which being doubled, is 8 hours 20 minutes, the length of the Night; and the Sun setting, which is at 7 a Clock 30 minutes, which being doubled, is 15 hours, the length of the day.

Proposition 9.

To find the Suns Amplitude.

The Amplitude of the Sun, is an Arch intercepted between the East and West points, and that part of the Horizon where the Sun riseth or setteth. The finding of the Amplitude, differeth little from the last Proposition, for having brought the degree of the Suns place to the Horizon, you must count how many degrees of the Horizon are intercepted between the East point, and that part of the Horizon where the Sun either riseth or setteth.

Example.

On the fifth of *May*, I desire to know the Suns Amplitude; Therefore bring the place of the Sun that day to the Horizon, and you will find 31° 15′ intercepted between the point of the Horizon, and the East point, which is the Suns true Amplitude Northerly.

Proposition 10.

How to find the Suns Declination any day of the year.

The Declination of the Sun, is an Arch of the Meridian intercepted between the Suns place and the Equinoctial; to find which, you must bring the degree in which the Sun is, to the Brazen Meridian, and there stay it, and count how many degrees of the Brazen Meridian

are contained between the Equinoctial, and the Suns place, for that is the Declination.

Example.

I would know what declination the Sun hath the fifth day of *May*, the Sun being 25 degrees in ♉, which being brought to the Meridian, you will find 19 degrees intercepted between that point and the Equinoctial on the Brazen Meridian, which is the declination required.

Proposition II.

To find the Meridian Altitude of the Sun any day of the year.

The Meridian Altitude of the Sun, is an Arch of the Meridian intercepted between the South part of the Horizon, and the degree in which the Sun is in. To perform which, turn the Globe about till the degree of the Sun be just under the Brass Meridian, then staying the Globe there, count how many degrees are contained between the degrees of the Sun, and the South part of the Meridians Intersection with the Horizon, and that is the Meridian Altitude.

Example.

On the fifth of *May*, it is required to find the Meridian Altitude of the Sun that day: the Suns place in the Ecliptick is 25 degrees in *Taurus*; Therefore bring that degree under the Brass Meridian, and you will find 57° 28′ to be intercepted upon the Brass Meridian, between the degree of the Sun and the South part of the Horizon, and that is the Meridian Altitude of the Sun that day.

Proposition 12.

How to know what Altitude the Sun shall have any hour of the day, and on any day of the Year.

Having rectified the Index of the Hour-Circle for the day proposed, and having found the place of the Sun by the second Proposition, turn the Globe about, till the Index of the Hour-Circle be just upon the time when you would know the Altitude; then staying the body of the Globe here, bring the Quadrant of Altitude to the East side of the Globe, and lay it over the Suns place, then the number of degrees con-

contained betwixt the Horizon and the Suns place, counted on the Quadrant of Altitude, is the Altitude of the Sun at that hour.

Example.

Let the time given be the tenth day of *April*, at which time (by the second Proposition) I find that the Sun is in the beginning of *Taurus*, and I would know what Altitude the Sun will have at 9 a Clock in the morning: the Index of the Hour-Circle being rectified for that day, turn the body of the Globe about till the Index of the Hour-circle lies just upon 9 a Clock, then staying the Globe there, lay the Quadrant of Altitude on the Suns place, (which is the beginning of *Taurus*) and the number of degrees between the Horizon and the Suns place, (counted upon the Quadrant of Altitude) is the true height of the Sun, which here I find to be 36 degrees, and that is the Altitude at 9 a Clock in the Morning, or 3 in the Afternoon, for the Sun hath the same Altitude at 11, 10, 9, 8, 7, 6, 5, 4. in the Morning, as it hath at 1, 2, 3, 4, 5, 6, 7, 8 in the Evening.

Proposition 13.

How to find the hour of the day by the Globe.

This Proposition cannot be wrought conveniently by the Globe simply, but the Altitude of the Sun must first be taken by some Instrument or other, and this is but the converse of the former Proposition, which performs thus: the Globe being set to the Latitude, and the Index of the Hour-Circle rectified, turn the Globe about till the degree of the Sun meets with the Altitude taken by the Instrument, and then will the Index of the hour Circle shew you the hour of the day.

Proposition 14.

To find both the Right and Oblique Assention of the Sun.

The Globe being set to your Latitude, bring the degree of the Sun to the Brazen Meridian, there staying it, then what degree of the Equinoctial is cut by the said Brazen Meridian, counting the same from the first point of *Aries*, for that is the right assention of the Sun that day; So the Sun being in the beginning of *Taurus*, his Right Assention will be found to be about 37° 45′, and his Oblique Assention to be 13° 28′.

These Propositions are common to both the Globes. I shall give you those Propositions that are only proper to the *Celestial Globe*, and in them we shall be very brief.

Proposition 15.

To find the Meridian Altitude of a Star, or the Altitude of a Star at any other time.

To find the Meridian Altitude, set the Globe be set to your Latitude, and then turn the body of the Globe about, till the Star being under the Brazen Meridian, and then the number of degrees of the Meridian intercepted between the North and South part of the Horizon, according as the Star is situated, is the Meridian Altitude thereof.

Now to find the Altitude at any other hour, turn about the Globe, till the Index of the Hour Circle be at the hour you would know the the Altitude of the Star in; and then apply the Quadrant of Altitude to the Star, and the degrees of the Quadrant cut by the Star, is his Altitude at that time.

Proposition 16.

To know at any time of the day, or night, what Stars be about the Horizon.

This is no other then to place the Globe in a true position at any time: Now if you would know what Stars are above the Horizon at any time of the day, you must take the Suns Altitude, and turning the Globe about till you bring the degree of the Sun just to the Altitude which you found the Sun to be of by Observation, in the Quadrant of Altitude, and then staying the Globe there, you will see all the Stars that are above the Horizon at that time.

The same is to be performed in the night, by any known Star, the Altitude of it being taken, and in the same manner.

Proposition 17.

How to find the Rising, Culminating, and setting of any fixed Star, and also what part of the Horizon he riseth and setteth in.

Having rectified the Index of the Hour-Circle, and placed the Globe according to the Latitude, then find out the Star, whose rising, calu-

caluminatings and ſetting you deſire, and bring him to the Eaſt ſide of the Horizon, then will the Index of the Hour-Circle ſhew you the time of his riſing; then bring the ſame Star under the Brazen Meridian, and there ſtaying the Globe, the Index will ſhew you at what hour the ſaid Star caluminates, and comes to the Meridian. Laſtly, Bring the ſame Star about till it toucheth the Weſtern part of the Horizon, & then the Index of the Hour-Circle will ſhew you at what hour the ſaid Star ſetteth, and by the Horizon you may know the Amplitude, that is on that part of the Horizon he riſeth or ſetteth.

Propoſition 18.

To find the hour of the Night by the Globe.

You muſt take the Altitude of ſome known Star by a Quadrant, or other Inſtrument, and then having rectified the Index of your Hour-Circle, turn the Globe about till you make the Star agree with the Quadrant of Altitude, according to the Stars Altitude, and then the Index of the Hour-Circle will point out to you the hour of the Night. Here you muſt note, That if the Star you obſerve be on the Weſt ſide of the Meridian, you muſt then turn the Quadrant of Altitude to the Weſt ſide of the Meridian; and if the Star be on the Eaſt ſide of the Meridian, you muſt turn the Quadrant of Altitude on the Weſt ſide of the Meridian.

The Deſcription and Uſe of an Inſtrument, called an Inclinatory Needle, *that doth (by a ſecret property of the Load-ſtone, together with the Magnatiſme of the Earth) ſhew you the Latitude of any Place, without Obſervation either of Sun, Moon, or Stars.*

This Inſtrument was firſt invented by that Excellent Philoſopher Dr. *Gilbert*, Phiſitian in ordinary to Queen *Elizabeth*, and hath the approbation of ſeveral other able and learned men hereunder mentioned, Mr. *Blundevil* hath written of it, as may appear in the latter end of *Maginus* his *Theoriques*, and by that expert Philoſopher Dr. *Ridley*, an Engliſh man, Phiſitian to the Emperor of *Ruſſia*, who hath largly treated of this Inſtrument, in his Book of *Magnetical Bodies*

dies and Motions. As also that famous Mathematician Mr. *Edward Wright*, in his Book of the *Correction of Errors in Navigation*, hath given a Geometrical Demonstration of the natural reason thereof, and hath from thence Calculated a Table of the Inclination of the Magnetical Needle in all Latitudes.

This Instrument hath also been lately commended to the consideration of this present Age, by the *Vertuosi*, or Royal Society in the Philosophical Transaction, *Vol.* 2. *Numb.* 24.

So that it may appear by all these Testimonies, that this Instrument hath somewhat of Excellency in it, and therefore may be thought worthy of our Consideration and Practice.

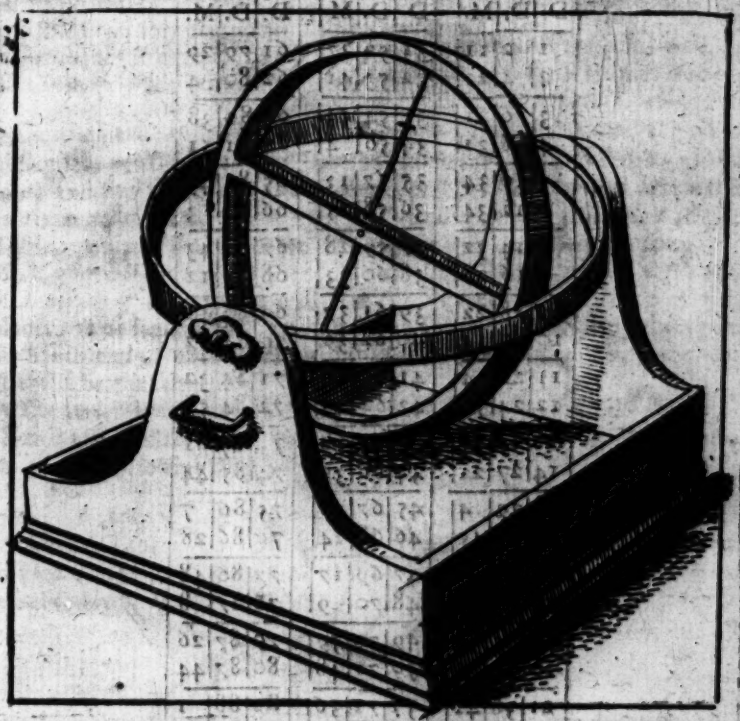
The Description of the Inclinatory Needle.

This Instrument containeth these Parts.

1. A strong Brass Ring wherein the Needle doth hang upon two small Pevits or Aleitrees, between two Bridges, and this Brass Ring hath on each side a Groove for a Glass to be put on each side; and formerly there used to be a Ring on the top to hold it on your finger, but this way being not altogether so convenient for use at Sea, therefore we have contrived it after a more convenient manner for Observation at Sea, and to hang like another Compass, in a Box, that it may be plyable to every motion of the Ship, according to this following Figure.

The

The Figure of the Inclinatory Needle.



The Uſe of the Inclinatory Needle;

The Magnetical Needle that hangs on his Pevits, between the two Bridges, in this Inſtrument, before it hath received any virtue from the Loadſtone, doth hang in *Equilibrio*, and will turn to any poſition whatſoever; but after it hath received the Magnetick vigor from the ſtone, it then becomes ſubordinate to the powerful commands of the great Magnet the Earth, which being placed to its Magnetical poſition, (*i. e.*) parallel to the Magnetical Meridian, then will the Needle reſpect its true point of Elevation or Depreſſion, according to the Latitude of the place where it is uſed, which may farther appear by this enſuing Table.

Lat. of pla.	Magnetical inclinat.	
D.	D.	M.
1	2	11
2	4	20
3	6	21
4	8	31
5	10	34
6	12	34
7	14	32
8	16	28
9	18	22
10	20	14
11	22	4
12	24	52
13	25	38
14	27	22
15	29	4
16	30	45
17	32	24
18	34	00
19	35	36
20	37	9
21	38	41
22	40	11
23	41	39
24	43	6
25	44	30
26	45	54
27	47	15
28	48	36
29	49	54
30	51	11

Lat. of pla.	Magnetical inclinat.	
D	D.	M
31	52	27
32	53	41
33	54	53
34	56	4
35	57	13
36	58	21
37	59	28
38	60	33
39	61	37
40	62	39
41	63	40
42	64	39
43	65	38
44	66	35
45	67	30
46	68	24
47	69	17
48	70	9
49	70	59
50	71	48
51	72	36
52	73	23
53	74	8
54	74	52
55	75	35
56	76	17
57	76	57
58	77	34
59	78	15
60	78	53

Lat. of pla.	Magnetical inclinat.	
D.	D.	M.
61	79	29
62	80	4
63	80	38
64	81	11
65	81	42
66	82	13
67	82	43
68	83	12
69	83	40
70	84	7
71	84	32
72	84	57
73	85	21
74	85	44
75	86	7
76	86	28
77	86	48
78	87	8
79	87	26
80	87	44
81	88	1
82	88	17
83	88	33
84	88	47
85	89	1
86	89	14
87	89	27
88	89	39
89	89	50
90	90	00

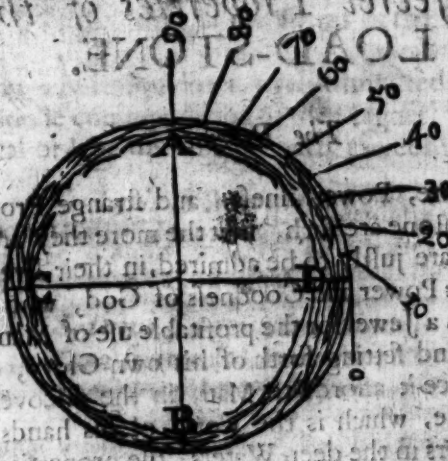
The

Therefore being in any part of the World, and you set this Instrument directly North and South by another Compass, being placed at a competent distance out of the Orbs of Attraction, then will the North or South end of the Needle dip to a certain Angle, which Angle being sought in this precedent Table, under the Title of *Magnetical Inclination*, right against it, in the Column next to it, under the Title of *Latitude of Places*, shall be shewn the Latitude of the present place.

Example.

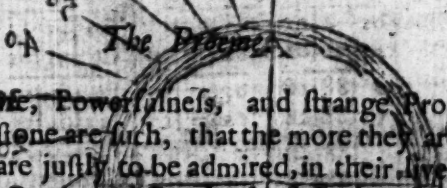
Suppose you have rectified your Instrument North and South, as before, and find the North end of the Needle to be depressed below the Horizon to an Angle of 72° 30′; Then if you look this Angle in the Table, you will find it in the fifth and sixth Column, under the Title of *Magnetical Inclination*; and in the fourth Column, under the Title of *Latitude of Places*, you will find 51 degrees the Latitude of the place. The same is to be understood in South Latitude, only that then the South end of the Needle will then shew they be depressed, and the Use will be the same.

The natural reason of this may be very lively illustrated by the application of a small sowing Needle round about a Terrella, in the manner of this following Figure.



Let the Figure A B C D, represent a Terrella or round Load-stone, A the North Pole, B the South Pole, A B the Meridian, C D the Equinoctial; Now if you suppose that the Quadrant A D were divided in 90 equal parts, shewing the several Latitudes of places upon the Earth; Then if you apply a Needle to the point D, it will conform it self to a parallel position to the line A B, but if moved further to 10 degrees, then shall it have a sensible Angle, and so to 20, 30, &c. until it cometh to 90 degrees, and doth it erect it self perpendicular upon the very Pole, from which Experiment may be gathered the natural reason of the position of the *Magnetical Needle* to the great Magnet the Earth, as this small sowing Needle hath to this Terrella or little Earth; or if a small Magnetical Needle be applyed after the same manner to this Stone, it will inform the same conclusions as the sowing Needle doth.

A short Appendix, shewing some of the secret Properties of the LOAD-STONE.



The Preface.

THE Nature, Powerfulness, and strange Properties of the Load-stone are such, that the more they are known, the more they are justly to be admired, in their lively expressing the infinite Power and Goodness of God, who hath created so precious a Jewel for the profitable use of Man, and for the enlarging and setting forth of his own Glory, especially in that assistance it affords to Man, in the discovery of the whole Universe, which is the work of his hands, and his mighty Wonders in the deep Waters, the properties not only serving

serving for Marine Affairs, but also by travelling by Land in vast and solitary Desarts, for moveable Sun-Dials in all places in the World, for the more ready and exact Chorography of any Countrey, or the true plotting of any ground, and for the following of any Mineral Vein that is void of Iron under the Earth; and also for Cole-Mines, with several other necessary Uses, retaining in it self, as it were, the very mirror of Philosophy, manifested by its Sympathetical Coition and Antipathetical Repulsion; with many other occult Operations, very admirable to behold, two especially that are treasured up in its dusky Entrails, one of Attraction, the other of Direction; it hath Substance, Virtue, and Operation, serving to many good purposes: therefore this Stone of all others may be accounted the most precious, wherein the Majesty of Nature doth most appear; which admirable Treasure God hath vouchsafed to reveal unto the weak knowledge of Man now towards the end of the World, being so plain to the meanest capacity; and that out of a base contemptible and dead Creature, as it seemeth to be, and yet filled with such Excellent and Wonderful Virtue, that all the Gems in the World have not the like.

Claudianus, a famous Poet, twelve hundred years since, saith as much in the commendation of the Magnet, whereas yet the Sereditical or Iron drawing property thereof was only known.

— Lapis est Cognomine Magnes
decolor obscurus vilis, &

And again,

Sed nova si nigri videas miracula saxi.
Tuno superas pulchros cultus, & quicquid Eois
Indus littoribus rubra scrutatur in alga.

But what would he have said, had he seen the true Closet of all Magnettical Miracles unlocked, as now it is a this day?

CHAP. I.

Of the name of the Stone, and of the Colour, and from whence they come, and how they were first found.

THis Stone is called *Magnes*, used under that promiscuous appellation, both by the *Greeks* and *Latines*; and as *Lucretius* writeth, the name is derived from the Country *Magnesia*.

The Greeks do call it Magnes *from the place,*
For that the Magnets *Land it doth imbrace.*

Plato saith, some call it *Lapis Heraclius*, from the name of *Heraclea*, a City of *Lydia*, whence it was first discovered, and upon the same account is called *Lapis Lydius*. *Theophrastus*, in his Book of Stones, for the same reason, calleth it *Herculeus*: Others think it denominated from *Hercules*.

Nicander thinks the Stone, so called, and so doth *Pliny* from him, from one *Magnes* a Shepheard; for it is reported, That he found it by his Hob-naild Shooes, and his Shepheards Crook that stuck to it, when he fed his Flocks in *India*, where he was a Shepheard.

Others call it *Siderites*, which in Greek signifies Iron. By us it is called a Load-stone, alluding to the two Stars in the Tayl of the Celestial Bear, called *Helice* and *Cynosura*, which were antiently called Load-stars, or Leading-stars; and therefore this Stone bears that appellation which now performs the same office.

This Magnet, or Load-stone, is found in diverse parts of the World, and most commonly in Iron Mines; and though it be pondrous and weighty, yet it is not found to be of the Iron Ore, neither containeth in it any mettal of it self, but hath a certain affinity and sympathy with Iron and Steel.

Of these there are of divers sorts, different each from other, as well in goodness as in colour, weight and force, but not in property (although many have judged that the cause of the variation of the Needle, to be according to the distance of the Mine from whence the Stone was taken, and the place where it is used) but there is no such thing, for all

all Stones whatsoever have all one and the same point of direction.

The first and best sort of these Stones come out of *East-India*, from the Coast of *China* and *Bengala*, and is of the colour of Iron, or Sanguine colour: These Stones are massy and weighty, and will draw or lift up the just weight of themselves in Iron and Steel; and these are of the finest sort, and are commonly sold for their weight in Silver in the *East-Indies*, where they grow, because the best or finest are very rare to be found, for it is commonly an entire Stone lying in the earth by it self, and no piece or part of any other: There is also another sort of a sadish colour found in *Arabia*, and the Red Sea, growing broad and flat, much like unto a Tile of a Chimney Hearth; these are not so weighty as those of *China*, but are very near as good, and the virtue continueth long on the Compass or Needle, that is touched upon these Stones.

There are of these Stones likewise in the *Levant*, in the Island called *Elba*, hard by a Town in that Island called *Porto Ferrato*, and are called there *Calamita Presa*, that is to say, the black Magnet, because there is another sort that are white and light, like unto a piece of dry Fullers Clay, and are called *Calamita Blanca*. These black Stones of *Elba* are mingled with white Veins; they are of no great force, nor their virtue of long continuance.

Also there are of these Stones in high *Almany*, that are full of holes like a Honey Comb, and lighter then the other, but better then they, these are of an Iron colour.

Another sort there are in *Norway* in the Iron Mines, as in *Langsound*, and other places, their colour is black mixed with gray; these are also of an indifferent force.

There are also some in the Mines of *Caraca* and *Cantabria* in *Spain*; and some there are found in *England*, but of very small force.

There are some found also in *Bohemia*, and several other places.

All these Stones are different one from another, as well in force, as in Colour, and Weight, yet all of one Operation in the Needle, shewing all one point of direction: which is a most wonderful and admirable providence of God to cause it so to be, for infinite would the destractions be if it were otherwise in the practical use of the Compass: for true it is, that God is mighty and marvellous in all his works; and truly his power is greatly shewn in this wonderful Miracle of Nature, as in any Stone in the whole Creation.

CHAP.

CHAP. II.

Of the Attractive Vertue of the Load-stone.

THat this Stone hath an attractive Operation, is apparently manifest; for if you apply a piece of Iron unto either of the Poles thereof, it will there hold it, and at a distance will also draw or attract a small piece of Iron, according to the vigor or imbecility of the Stone; but what strength soever it hath, it may be artificially improved to be greater then can by it self be discovered, which is to be performed by the applying a smooth and bright piece of Iron to either Pole of the Stone, and it will immediately deliver its vertue unto it, the vertue being herein contracted in this piece of Iron; the Stone doth manifest it self to have ten times more strength; for this cause therefore are Load-stones capped with Iron; for the artificial augmentation of their strength.

And this vertue is freely communicated from it self to any thing else that is capable of its reception, so that a piece of Steel, having received strength from the Stone, that will also attract another piece of Steel in proportion to that vertue that it hath received. This experiment I have often tryed upon my Load-stone; for by touching of a Knife upon it, it shall take up a Key of two ounces weight; and that within the Sphere of the Stone it shall deliver the vertue into a piece of Iron, and not touch the Stone at all; and likewise over the Stone it shall cause one piece of Iron to hang to another; so wonderful is the attractive quality of this Stone, manifested in these and the like Expertiments.

CHAP.

CHAP. III.

Of the Sympathetical and Antipathetical property in the Load-stone.

IF two Magnetical Needles being touched upon the Load-stone, the North and South ends of these two Needles will each of them apply themselves respectively to those Poles from whence they received their Magnetical life, to wit, the North end of the Needle will fly to the North end of the Stone, and the South end of the Needle to the South end of the Stone, which denotes their mutual sympathy; but putting the North end of the Stone to the South end of either of the Needles, when it is upon a Pin, the South end of the Needle will immediately fly away; and if you put the South end of the Stone to the North end of the Needle, it will also discover an opposite Antipathetical Nature.

But a contrary Operation there is yet in the two Needles to that of the Load-stone, for if one of the Needles being hung upon a Pin, and if you apply the North end of the one Needle to the North end of that upon the Pin, it shall immediately fly away, which denoteth a contrary Operation in the Needle to that of the Load-stone, and the South end of one Needle will immediately come to the North end of the other.

The same property of Sympathetical Coition, and Antipathetical Repulsion, is also discovered by two Load-stones floating in two little Boats, in a great Bason of Water, the two Poles of either Stone being disposed parallel to the plain of the Horizon, and if you put both the South Poles together, they shall avoid the contact of one another by a natural antipathy; but if the North Pole of one be directed to the South Pole of the other, they will immediately manifest their natural sympathy one to another, and will cleave together by a strong Attraction.

This is also apparently evident between the great Magnet the Earth, and a Load-stone, for if you put a Load-stone in a small string, and let it hang in the Air, or else to float it in the Water in a wooden Dish, and putting the North end of the small Magnet toward the North

end

end of the great Magnet the Earth, it shall immediately change its position, and turn its North Pole towards the South Pole of the said great Magnet.

CHAP. IV.

Of the Consequences that follow the various dividing and cutting of the Load-stone.

IF a Load-stone be confusedly broken by violence into many pieces, each of the individual pieces shall be an intire Load-stone, having both its Poles distinctly of it self, with all the other properties that were in the Stone before it was broken.

But if a Load-stone be divided in the midst, between the two Poles, in the very Equinoctials, then is it absolutely two intire Load-stones, and those parts which were the Equinoctials before, are now become two Poles, and the two Poles that were Poles before, do continue the same.

But if a Stone be cut meridionally quite through the two Poles thereof, so that one Axis is now converted into two, and each of them remove into each Stone, so that it is also become two intire Load-stones, and the Axis of them will retire into the gravity of either piece, directly parallel to the Axis, as was before, the Stone was divided; and if you joyn these two pieces together again, the two Axis will again become one, which is most admirable to behold.

But if you cut off a piece of the Stone at the very Pole, in a parallel Section, the virtue of that piece will immediately retire from it unto the main Stone, and will scarcely have any virtue at all therein; but applying this small piece that was cut off to the same place again, and the Stone will forthwith impart the same virtue as was before into this piece so cut off, so long as it doth abide in that place, but when it is removed, it doth again recal its virtue from the said piece. This I have experimented in a Stone of a very considerable piece.

And in the same manner, if you apply a weak Stone to the Poles of a strong one, the strong Stone will impart of its virtue to the weak Stone, making it to be as strong as it self so long as it is its Neighbour, but

but when this weak Magnet deſerts this neighbourly propinquity, the ſtrong Magnet will draw its virtue to its ſelf again, and will truſt it no further then the power of its recal.

CHAP. V.

To find the Poles of any Stone.

THere are ſeveral wayes for the performance of this Experiment; First, You may have a thin piece of Steel about an inch in length, and $\frac{1}{4}$ of an inch broad; this piece of thin ſteel being bent circular, and laid on the ſtone, will immediately lie parallel to the Axis of the Stone, and direct which way the Poles do lie. Which being diſcovered near where they lie, you may find them more exactly by a ſmall piece of a ſowing Needle, which being laid on the Stone, if it be near either of the Poles, will elevate one end thereof; then move it farther and farther till it doth erect it ſelf perpendicular, and that very point will be the Pole of the Stone.

Now to know which Pole it is, you may apply a ſmall Needle of a Dial to it, and if the Pole draw the North end of the Needle, then is that the North Pole of the Stone, and the contrary.

Or otherwiſe, You may find the Pole by a ſowing Needle and a Thread, by hanging it over the Stone, where you ſuppoſe the Pole to be, and keep it a little ſhort from the Stone, and the end of the Needle will directly point to the Pole of the Stone.

CHAP. VI.

Whether Onions or Garlick doth obſtruct the Operation of the Load-ſtone.

THere is a common received Opinion, that if a Load-ſtone be rubbed over with Garlick or Onions, that it will obſtruct the virtues thereof; or if a Knife being touched upon the Load-ſtone, and afterwards to cut an Onion or Garlick therewith, that it will immediately looſe its virtue.

This conceit hath alſo been countenanced by the Antients; but if you are pleaſed to make tryal of it, you will find it to be but a meer fallacy. It is alſo as falſe that the Diamond doth hinder the virtue of the Load-ſtone while it is near it.

CHAP. VII.

A delightful Experiment performed by the Load-ſtone, *repreſenting the Engaging of two Armies in Battel.*

FOr the performance hereof, you muſt have a Braſs or Pewter Plate, and upon this Plate put on ſeveral little heaps of the filings of Iron, with ſome ſhort bits of ſowing Needles, and put them in order of a Battel, one main body againſt another, alſo with their right and left Wings, and their Forlorne Hopes; this being done, bring the Load-ſtone under the Plate with one of the Poles upward, and put it ſi ſt toward one of the right Wings of the Army, and they will immediately receive an Alarm, and as it were, ſtand to their Arms, then move the Stone toward the other Wing of the Enemy, and they alſo will receive the like Alarm; and then by moving the Stone to and fro under the Plate, you will put both parties in a motion, in a charging poſture, and one to charge the other in a deſperate engagement, and

and one to come within the other, and ſo you may at laſt engage the main bodies of the Armies; and there you may ſee that ſometimes they are Conquerors, and ſometimes conquered, which is cauſed by the ingenious motion of the Stone with your hand under the Plate; and the Short bits of the Needles may repreſent their Generals and Commanders, which will be very full of action, where you may ſee ſometimes that there will be twenty or more of the Common Souldiers to fall foul of the ſaid Commanders; and if between theſe Armies you put ſmall Breaſt-works and Trenches made with Sand, and filings put in the Trenches, you will then have repreſented the ſudden riſing of them one againſt another, as if they lay in ambuſh, waiting for an opportunity againſt their Enemies.

CHAP. VIII.

To make a Sowing Needle to ſwim upon the ſurface of the Water, and to play up and down like a Fiſh; and alſo to find out the Magnetical Meridian.

TAke a ſmall ſowing Needle, and touch the two ends thereof upon the two Poles of the Stone, and then having a glaſs of Water before you, take the Needle very lightly between your finger and thumb, and lay it lightly on the ſurface of the Water, ſo that it break not through, and there it will lie; then take a Knife that hath been touched with the Load-ſtone, and bring it to and again about the edge of the Glaſs, and the Needle will follow it up and down, and will play up and down on the ſuperfecies of the Water like a Fiſh, and then take away the Knife, and the Needle will immediately poſite it ſelf to the Meridian, pointing due North and South. Such an inferior Inſtrument as this may ſtand men in great ſtead, in time of great ſtraits & exigencies if they ſhould be at Sea, and their Compaſs be taken from them; for if you put a Needle, being toucht, through a ſmall piece of Cork, it will then perform this effect exceeding well in all ſtorms and tempeſts whatſoever, being born up by the Cork on the top of the Water, and the poſition thereof will be continually in the Meridional.

CHAP. IX.

To infuſe Magnetical Virtue into a Needle without the help of a Load-ſtone.

IRon being a Mineral of the Earth, and having a Sympathetical quality with the Load-ſtone, acquiring this verticity from the Magnatiſme of the Earth, being diſpenſed according to the various poſitions thereof; for all Iron, whoſe poſition is parallel to the Axis of the World, or perpendicular to the Horizon, the upper part thereof, ſhall have North Virtue, and the lower part South Virtue, as bars in Windows, Caſements, Tongs and Fire-Forks, and all ſuch things, *&c.* And according to the length of time of the poſition of any ſuch piece of Iron, the ſtronger virtue it doth contract; ſo that once I made an Experiment upon a ſmooth piece of Iron, which had for ſeveral years been in a perpendicular poſture, and I filed the upper end thereof bright, and touched a ſmall new Needle thereon, the South end I toucht upon the North upper part of the Iron, and the North end upon the South or lower end of the Iron, as I do on the Load-ſtone, and I found the Needle to play indifferently well, and to conform it ſelf to the Magnetical Meridian.

CHAP. X.

A delightful Experiment performed with two ſowing Needles, being touched upon the Load-ſtone.

IF you touch two ſowing Needles contrary one to another, that is to ſay, the point of one Northerly, and the point of the other Southerly, and put them into two ſmall pieces of Cork, and put them thus in a Baſon of Water, one at the one ſide, and the other at the other ſide of the Biſon, you ſhall ſee them, as it were, quickned with

a vital ſpirit, even ſo to move the one end towards the other; at the firſt, fair and ſoftly, but when they draw near, they will ruſh together with great violence, the point of one ſtriking preciſely at the point of the other? you muſt place the Needle that is touched from the North, on the South ſide of the Baſon, and the other on the other ſide, otherwiſe the heads, and not the points, will run together.

CHAP. XI.

Of Cementing and piecing of Load-ſtones.

IF a Load-ſtone chance to be broken, it will not at all be detrimental to the virtue of the Stone, provided that they be joyned together in the ſame place where they were broke off, which may be ſet together very ſtrongly, by the help of a Cement prepared for that purpoſe, which is thus to be prepared.

Take the fine pouder of Load-ſtone, and half ſo much pouder of Brick made very ſmall, one part of Burgundy Pitch, half ſo much Roſin, and a ſmall portion of unwrought Wax; mingle theſe over a ſoft fire, and heat the two pieces of the Load-ſtone very hot, then take of this Cement, while it is hot, and lay it on very thin upon the two pieces, and then joyn them together very hard, and as cloſe as you can, and let it ſo ſtand until it be cold, and you ſhall have it fully as ſtrong as if it were an intire ſtone, and not to be ſevered but by a great fire.

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FINIS.

POST-SCRIPT.

Courteous Reader,

THese may be to inform you, that whereas there being frequent complaints made that the *English* hath not as yet manifested that forwardness in the promotions of things of publick concernment, for the general benefit of Navigation, as the *Hollander* hath done, in the making of *Waggoners* and *Charts* for the Sea, and things of that nature, although we come not behind them in any Theoretical knowledge, yet for want of the publick Informations of the Experiences of able men of our Nation, as to the Depths and Soundings, Dangers, and making of the form of the Land in places where they have been, and things of that nature, which doth much reflect upon the honour of our noble spirited Countrey men, and gives advantage to our Neighbours the *Hollanders* to be furnishing of us with *Waggoners*, *Charts* and *Draughts*, and such things, by which means a great treasure of Money is transported out of our Native Countrey to the enriching of them, and to the impoverishing of our selves. Therefore (worthy Gentlemen) I do here make known unto you, that I intend, with the assistance of God, and am at the present upon making (at my own cost and charge) a Sea *Waggoner* for the whole World, with *Charts* and *Draughts* of particular places, and a large Description all the Roads, Harbors and Havens, with the Dangers, Depths and Soundings in most parts of the World, which work was never yet performed by any; and therefore my humble request is to all ingenious persons, who are desirous for the promotion of a publick good, for the honour of our Nation, and for their own worthy commendations, that they would be pleased to communicate any of their Informations and Experiences of things of that nature above specified unto me, they shall be very thankfully received, and faithfully exposed to the use and benefit of the publick, and shall much engage him, whose great desire is to be serviceable to his Countrey.

John Seller.

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ERRATA.

ERRATA.

PAge 2, Deff. 3d, between the word [Margin] and the word [and] read, a Triangle is a 3 sided and a 3 angled figure. In *pag.* 3. in the third Deff. of 4 sided figures, *read*, haying equal sides, and opposite Angles equal. *P.* 8. the last letters of the fifth Def. *f.* ZAN, *r.* PAS. *p.* 11. *l.* 2. Deff. 27, *f.* Cirdle *r.* Girdle. *p.* 27. last line but three, *f.* Rulres, *r.* Rulers. the same fault in the last line but one. *p.* 23. *l.* 4. *f.* point C, *r.* point D. *f.* line A C, *r.* A D. *p.* 105. *l.* 2. *f.* illustartion, *r.* illustration. In the Kalendar, in the month of *April*, over all the Columns of the Suns place, *f.* ıı, *r.* ♈. *p.* 163. in line 6 & 9, from the bottom, *f.* parallel, *r.* paralax, *f.* Sol, *r.* Sun. *p.* 165. *l.* 22. *f.* and, *r.* &. *p.* 227. under the figure of the Instrument, a blanck place was to have been left vacant for an additional part of the Instrument, but was casually omitted; therefore that, with the other appurtenances, is printed in a Paper by it self, and is stitched in between the pages 226 & 227. *p.* 285. *l.* 6. *f.* Colors, *r.* Colures.